Giga-tronics

OPERATING AND MAINTENANCE MANUAL

80350A SERIES PEAK POWER SENSORS FOR PEAK AND CW POWER MEASUREMENTS

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GENERAL DESCRIPTION

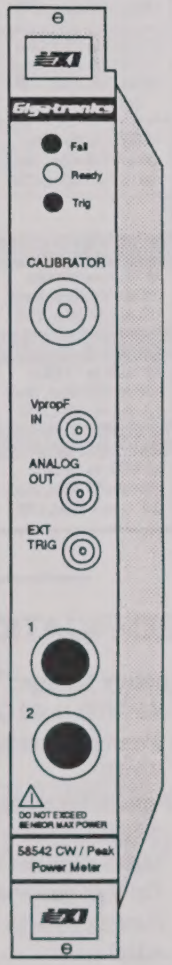
The 80350A Series Peak Power Sensors perform true sample based peak power measurements on pulsed signals. The sensors are compatible with the 8540 Series Universal Power Meters (see note on page 4), and the Model 58542 VXI Universal Power Meter.

The 80350A Series Sensors operate from 45 MHz to 18, 26.5, and 40 GHz. High power versions, 5W, 25W, and 50W, are available to 18 GHz. Please note maximum power ratings of the sensors and high power attenuators carefully. Excessive Peak or CW power levels will damage the attenuators and/or the balanced detector element.

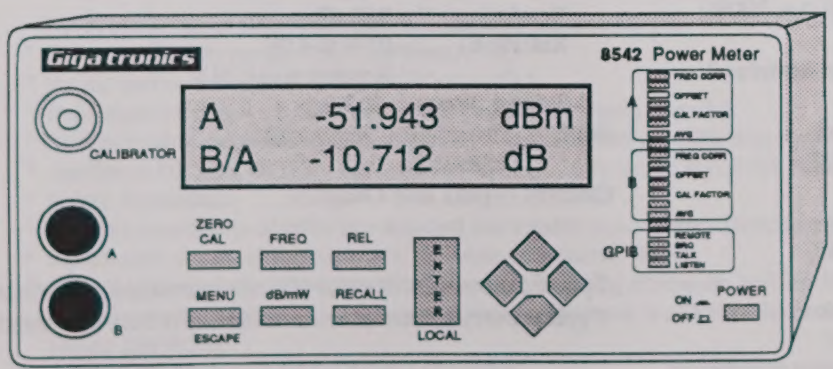
The 80350A Series have three modes of operation: CW, Internally Triggered Peak, or Externally Triggered Peak. When operated in the peak modes, trigger point-to-sample point delay ("Sample Delay") is adjustable from -20 ns to 100 ms in 0.5 ns steps. Trigger levels are also adjustable.

Giga-tronics' proprietary power sweep calibration system provides excellent linearity from -20 dBm to +20 dBm (Peak) and -30 dBm to +20 dBm (CW). Sensor frequency response variations are automatically compensated for by using sensor Cal Factors stored in EEPROMs in the power sensors. This unique approach can be configured to provide automatic sensor frequency response correction.

A detector output signal is provided for viewing the detected envelope of the pulsed RF waveform on an oscilloscope. Use of a digital oscilloscope is strongly recommended.



Model 58542 VXIbus Universal Power Meter



Model 8542 Universal Power Meter

PEAK POWER SENSOR SELECTION GUIDE

Model	Frequency Range / Power Range	Maximum Power	Power Linearity[4]	VSWR	RF Connector	Dimensions		Weight
						Length	Diameter	
STANDARD PEAK POWER SENSORS								
80350A	45 MHz to 18 GHz -20 to +20 dBm, Peak -30 to +20 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.05 dB/10dB	45 MHz - 2 GHz: 1.12 2 GHz - 12.4 GHz: 1.22 12.4 GHz - 18 GHz: 1.37	Type N(m) 50Ω	165 mm (6.5 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)
80353A	45 MHz to 26.5 GHz -20 to +20 dBm, Peak -30 to +20 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm: ±0.00 dB -20 to +20 dBm: ±0.1 dB/10dB	45 MHz - 2 GHz: 1.12 2 GHz - 12.4 GHz: 1.22 12.4 GHz - 18 GHz: 1.37 18 GHz - 26.5 GHz: 1.50	Type K(m)[1] 50Ω	165 mm (6.5 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)
80354A	45 MHz to 40 GHz -20 to +0.0 dBm, Peak -30 to +0.0 dBm, CW	+23 dBm (200 mW) CW or Peak	-30 to -20 dBm: ±0.00 dB -20 to 0.0 dBm: ±0.2 dB/10dB	45 MHz - 2 GHz: 1.12 2 GHz - 12.4 GHz: 1.22 12.4 GHz - 18 GHz: 1.37 18 GHz - 26.5 GHz: 1.50 26.5 GHz - 40 GHz: 1.92	Type K(m)[1] 50Ω	165 mm (6.5 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)
5W PEAK POWER SENSOR [2,5]								
80351A	45 MHz to 18 GHz 0.0 to +40 dBm, Peak -10 to +37 dBm, CW	CW: +37 dBm (5 W Avg.) Peak: +43 dBm	-10 to +0 dBm: ±0.00 dB +0 to +40 dBm: ±0.05 dB/10dB	45 MHz - 4 GHz: 1.15 4 GHz - 12.4 GHz: 1.25 12.4 GHz - 18 GHz: 1.35	Type N(m) 50Ω	200 mm (7.9 in)	37 mm (1.25 in)	0.3 kg (0.7 lb)
25W PEAK POWER SENSOR [3,5]								
80352A	45 MHz to 18 GHz +10 to +50 dBm, Peak 0.0 to +44 dBm, CW	CW: +44 dBm (25 W Avg.) Peak: +53 dBm	0.0 to +10 dBm: ±0.00 dB +10 to +50 dBm: ±0.05 dB/10dB	45 MHz - 6 GHz: 1.20 6 GHz - 12.4 GHz: 1.30 12.4 GHz - 18 GHz: 1.40	Type N(m) 50Ω	280 mm (11.0 in)	104 mm (4.1 in)	0.3 kg (0.7 lb)
50W PEAK POWER SENSOR [3,5]								
80355A	45 MHz to 18 GHz +10 to +50 dBm, Peak 0.0 to +47 dBm, CW	CW: +47 dBm (50 W Avg.) Peak: +53 dBm	0.0 to +10 dBm: ±0.00 dB +10 to +50 dBm: ±0.05 dB/10dB	45 MHz - 6 GHz: 1.25 6 GHz - 12.4 GHz: 1.35 12.4 GHz - 18 GHz: 1.45	Type N(m) 50Ω	280 mm (11.0 in)	104 mm (4.1 in)	0.3 kg (0.7 lb)

SPECIFICATIONS

Frequency Range: [7]
45 MHz to 40 GHz

Peak Power Dynamic Range: [7]
40 dB

CW Power Dynamic Range: [7]
50 dBm
(see Selection Guide above
for high power sensors)

Rise Time: (10% to 90%, 0 dBm = 100%)
<100 ns

Fall Time: (90% to 10%, 0 dBm = 100%)
<250 ns

System Linearity at 50 MHz for Standard Peak Power Sensors:
±0.13 dB from -30 to +16 dBm
±0.13 dB +(+0 dB, -0.05 dB/dB)
from +16 to +20 dBm

Zero Accuracy:
Zero Set: [6] < *±1.0 µW*, Peak;
< *±0.05 µW*, CW
Zero Drift: [6] < *±1.0 µW*, Peak
< *±0.05 µW*, CW
in 1 hour at constant temperature,
24 hour warmup

Noise Uncertainty: [6]
< *±1.0 µW, Peak;* < *±0.05 µW*, CW at constant temperature, measured over a 1 minute interval, 24 hour warmup

Sample Delay Timing: [11]
Delay Range: -20 ns to 104 ms
Delay Resolution: 0.5 ns
Delay Jitter: *±2.0 ns*

Trigger Level Set Range:
Internal: -30 to +20 dBm
Resolution : [12] 0.01 dB
External: 0.0V to 4.0V
Resolution to 0.01V
Trigger Jitter: < *±2.0 ns*

Settling Time: (50% to within 3%)
< 250 ns

Control Inputs and Outputs:

Specifications describe the sensor's warranted performance. Typical performance (shown in italics) is non-warranted.

Specifications subject to change without notice.

[1, 2, 3, 4, 5, 6, 7, 11, 12] - see bottom of page 3

POWER SENSOR CAL FACTOR UNCERTAINTIES

Freq. (GHz)		Sum of Uncertainties (%)[8]					Probable Uncertainties (%)[9]		
Lower	Upper	80350A	80353A 80354A	80351A[10]	80352A[10]	80355A[10]	80350A	80353A 80354A	80351A[10] 80352A[10] 80355A[10]
0.1	1	1.61	3.06	9.09	9.51	10.16	1.04	1.64	4.92
1	2	1.95	3.51	9.43	9.85	10.50	1.20	1.73	5.04
2	4	2.44	4.42	13.10	13.57	14.52	1.33	1.93	7.09
4	6	2.67	4.74	13.33	13.80	14.75	1.41	2.03	7.17
6	8	2.86	4.94	13.52	13.99	14.94	1.52	2.08	7.25
8	12.4	3.59	6.04	14.25	14.72	15.67	1.92	2.55	7.56
12.4	18	4.09	6.86	19.52	20.97	21.94	2.11	2.83	12.37
18	26.5	---	9.27	----	----	----	---	3.63	----
26.5	40	---	15.19	----	----	----	---	6.05	----

Trigger Input: [SMB(jack) connector]
TTL External Trigger Input (absolute maximum = 10V).
110kΩ Impedance.

Detector Out: [SMB(jack) connector]
Monitor real time pulse waveform on an oscilloscope with this voltage output (uncalibrated).
(High Impedance - Do Not Terminate)

Sample Delay: [SMB(jack) connector]
High, 5V, between trigger and sample points. Connect to digital oscilloscope channel 2 for triggering and sample point identification.
(High Impedance - Do Not Terminate)

NOTE: Maximum cable length = 3 meters

INCLUDED ACCESSORIES

3 ea SMB(plug) to BNC(m) cables, 2 m (6 ft) long.
Cable Harness Wrap, 1.2 m (4 ft) long

[1] The K connector is electrically and mechanically compatible with the APC-3.5 and SMA connectors.
[2] Power coefficient equals <0.01 dB/Watt(AVG.)
[3] Power coefficient equals <0.015 dB/Watt(AVG.)
[4] For frequencies above 8 GHz, add power linearity to system linearity.
[5] Peak operating range above CW maximum range is limited to <10% duty cycle.
[6] Applies to 80350A, 80353A and 80354A. 80351A 100x larger. 80352/5A 1000x larger.
[7] Sensor Dependent
[8] Includes uncertainty of reference standard and transfer uncertainty. Directly traceable to NIST.
[9] Square root of sum of the individual uncertainties squared (RSS).
[10] Uncertainties include 3% repeatability when reconnecting attenuator, and 3% for attenuation uncertainty and mismatch of sensor/pad combination. Attenuator frequency response is added to the Sensor Cal Factors which are stored in the sensor EEPROM.
[11] See page 7 of this manual for delay explanation.
[12] Accuracy not guaranteed.

OPTIONAL ACCESSORIES

Option 02: 12 ft SMB(plug) to BNC cable

Option 03: SMB(plug) to SMA(jack) adapter

COMPATIBLE POWER METERS

8541 Single Channel Universal Power Meter

8542 Dual Channel Universal Power Meter

58542 Dual Channel VXI Universal Power Meter

NOTE: If the 80350A Series sensors will be used with a Model 8542 (dual channel) Power Meter, the 8542 must be configured to code 06 or higher or an asterisk (*) must be appended to the code number. (The code number is printed next to the serial number on the label located on the rear panel of the instrument.)

OPERATION

When a sensor is first connected to an 8540 Series Universal Power Meter or to a Model 58542 VXI Universal Power Meter, it is necessary to calibrate the sensor to the power meter's sensor input using the power meter's built in power sweep calibration system. The power meter will not allow measurements to be performed until this calibration is completed successfully. It is good practice to repeat this calibration process whenever the ambient operating temperature of the sensor varies by more than ±5°C (±9°F), and whenever any external connections or external loads are added or removed from the sensor. (Always allow 30 minute warm up before calibrating the sensor.)

NOTE: These instructions show 8540 Series Power Meter front panel keys in **BOLD** and menu displays in *ITALICS*.

Operational description of the 80350A Peak Power Sensor applies to applications with either the 8540 Series Universal Power Meters (8541/2) or the Model 58542 CW/Peak VXI Power Meter. Except where noted, the front panel descriptions apply only to the 8540 Series Power Meters. SCPI command sequences apply to the 58542 VXI Power Meter.

Power Sweep Calibration

The 80350A Peak Power Sensors are calibrated to the meter using the same procedure as with the other sensors used with the 8541/2 Power Meters or the 58542 VXI Power Meter. Connect the channel A sensor to the CALIBRATOR port, and press the **ZERO/CAL** key.

Following the successful completion of Power Sweep Calibration, the 8541/2 display will automatically show the current value of sample delay for your 80350A Series Peak Power Sensor. If the sample delay does not appear, press the **RECALL** key, select *PRESET*, and press **ENTER**.

If you are using the dual channel 8542 Universal Power Meter, verify that only one 80350A Series Peak Power Sensor is attached. The 8542 will automatically display peak power on one line and sample delay on the other. When two sensors are attached the display will automatically default to display the two power levels. Some test procedures, A/B ratio measurements for example,will be easier after performing some configuration of the display parameters. Press the **MENU** key, select *A, B, A/B . . . B-A* with the arrow keys, and press **ENTER**. This menu will allow you to select various power measurements as well as "*DLY*$_A$" and "*DLY*$_B$" for the two line display.

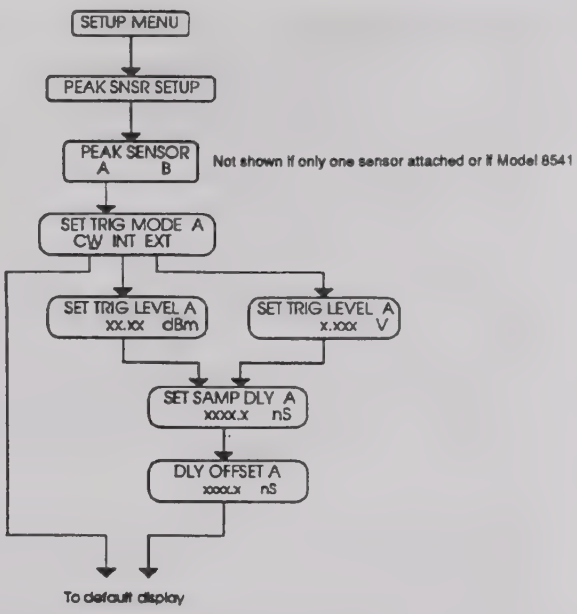
5W, 25W, and 50W Peak Power Sensors

Power Sweep Calibration of the 5W, 25W, and 50W (80351A, 80352A, and 80355A, respectively) Peak Power Sensors require you to disconnect the high power attenuator before you connect the sensor directly to the front panel "CALIBRATOR" connector. When power sweep calibration is completed, re-connect the high power attenuator to the sensor connector.

Proper connector alignment is shown by small black arrows printed on the attenuator and sensor labels. The serial number on the sensor housing and the serial number on the high power attenuator should match. During manufacture, the frequency response of the attenuator is calibrated and entered into the peak power sensor EEPROM as frequency calibration factors. This technique improves the accuracy and repeatability of your measurements.

DO NOT EXCEED 200 mW
(+23 dBm) PEAK OR AVERAGE

Applying excessive input power will damage or destroy the power sensor element.



Peak Sensor Setup Menu Tree

Triggering

Zeroing

Be sure to zero the sensor prior to taking critical measurements in the bottom 10 dB of the peak power sensor's dynamic range. For Standard Peak Power Sensors, this level is -10 dBm.

When making dual channel power measurements, be sure to re-zero the sensors whenever another sensor is attached or disconnected.

1) Turn OFF the RF source.
2) Press the CAL/ZERO key.

The sensors will zero automatically. The 8540 power meters know when a sensor is attached to the CALIBRATOR port. When a sensor is not attached to the Power Sweep Calibrator, the power meter automatically initiates the zeroing procedure (if only one sensor is connected to the meter). Be sure to deactivate the RF source for zeroing. Leaving the sensor attached to your measurement test ports during zeroing properly accounts for test setup ground noise and metal to metal contact thermal emfs.

The 8541/2 instruments will not display a new peak power reading until the 80350A sensor is triggered. The default configuration is internal triggering (INT) at -20 dBm. Press the **MENU** key, select *SETUP MENU*, select *PEAK SNSR SETUP*, (select sensor *A* or *B* if necessary), and then select *INT* triggering. After selecting INT triggering you can enter a new internal trigger level. Be sure that the value selected is three dB or greater below the peak power level of the signal being measured. If you are attempting to trigger at excessively low power levels, measurement repeatability and noise performance can be improved by using external triggering (EXT).

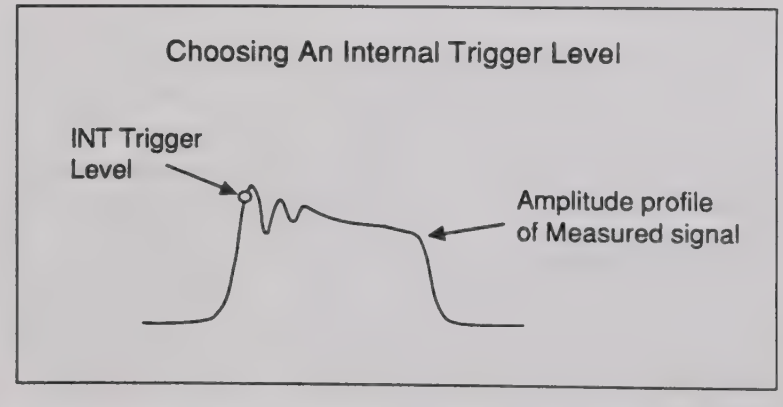
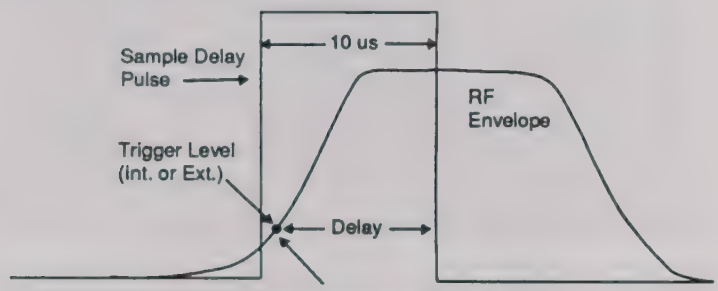


Figure 1. Internal trigger levels must be lower than signal amplitudes.

The 80350A Series EXT trigger port is on the back of the sensor, not the power meter. A set of three SMB(f) to BNC(m) cables are included with each 80350A Series sensor. The EXT trigger input impedance is 110KΩ. This allows you to use TTL level signals without damaging the input circuitry. However, the input impedance match might cause triggering line reflections (and potential false triggering) when fast, 50Ω, trigger sources are used.

This can be resolved by setting the EXT trigger level (see the *PEAK SNSR SETUP* menu).

The CW power measurement mode is also selected in the *PEAK SNSR SETUP* menu. CW measurements are automatically performed on a continuous basis.



58542 VXI Power Meter SCPI Compatible Commands

```
OUTPUT @Pwr_mtr;"SENS1:TRIG:SOUR INT"      ! Selects Internal Triggering
OUTPUT @Pwr_mtr;"SENS1:TRIG:DEL 10E-06"    ! Sets Sample Delay Position to 10 µs
WAIT 200                                   ! Wait 200 ms for Sample Time Set
OUTPUT @Pwr_mtr;"MEAS1?"                   ! Take a Measurement
ENTER @Pwr_mtr; Peak_pwr_rdg
```

Figure 2. 80350A Sensor Timing Diagram (showing VXI specific SCPI commands) (Overshoot on the monitor output is not necessarily present on the measured waveform.)

"Sample Delay" is the time value in "ns", "us", or "ms" that appears on the 8540 Series display after an 80350A Series sensor has been calibrated. This is the length of time between the trigger point and the sample point on the pulsed signal. This capability allows you to measure the power level of your pulsed signal at any time point along its amplitude path. The power level displayed is the true, sampled signal level at the time position that you specified; the pulse level is not interpolated from two adjacent samples as is common in random sampling oscilloscope-type peak power meters.

IS THE SENSOR TRIGGERING?

A measurement will not be possible until the peak power sensor is triggered. The 8540 Series Power Meters will display "NO TRIG" until a valid trigger is received. The following trigger verification technique is valid for both 8540 Series and 58542 VXI Power Meters.

If you need to verify triggering, connect the "Sample Delay" output on the back of the 80350A Series sensor to an oscilloscope using one of the SMB(plug) to BNC(m) cables provided with the sensor. Set the scope channel to DC coupling, 1.0 µs per division. Use rising edge ("Normal") triggering at about 0.5V trigger level. Set the sensor sample delay to 2.0 µs.

The sample delay pulse will appear each time the sensor is triggered. If a pulse does not appear on the scope display, the sensor is not triggering. Check the triggering configuration and re-adjust it if necessary. (NOTE: An analog oscilloscope may show a dim trace when the repetition rate is low.)

A quick check that can be made on the 8540 instrument for triggering without using an oscilloscope is to press the **dB/mW** key twice. This will clear the current reading and display NO TRIG until a valid trigger is received.

Adjusting Sample Delay

Sample delay is fully adjustable from -20 ns to 104 ms. On the 8541/2 front panel, use the arrow keys to position the cursor and adjust the time values. Seven digits, four to the left of the decimal point and three to the right of the decimal point, can be edited in the "us" (μs) and "ms" ranges. (See Figure 3, below, for an example.) The "ns" range allows four digits to the left of the decimal, but will only allow a ".0" or ".5" to the right of the decimal.

The 0.0 ns time delay setting will be close to the trigger level when internal triggering is used. If your measurements require definition of the 0.0 ns position, use Sample Delay Offset to adjust for these small triggering variations.

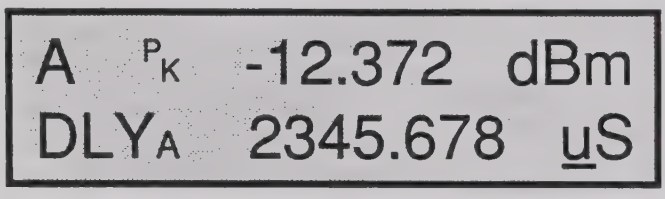


Figure 3. The up/down arrow keys on the 8541/2 front panel also adjust the units display to "ns", "us" , or "ms"

Full 0.5 ns resolution is always possible - regardless of the front panel units display. On the "ms" ranges, small "ns" level increments in sample delay can be performed by incrementing *SAMPLE DLY OFFSET* in the *PEAK SNSR SETUP* menu. In addition to allowing control of small "ns" range sample delay increments while you are currently displaying "ms" ranges, sample delay offsets allow you to compensate for cabling and circuitry time delays in your test setup.

Sample Delay Display

With a single peak power sensor attached, the default display after attachment and calibration of the sensor will have the power displayed on one line and the sample delay displayed on the other line.

The default for channel A will be as shown in Figure 3a, below:

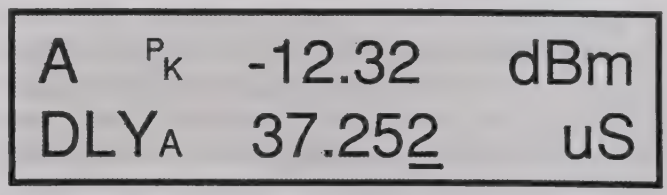


Figure 3a. Channel A Default Sample Delay Display

The default for channel B will be as shown in Figure 3b, below:

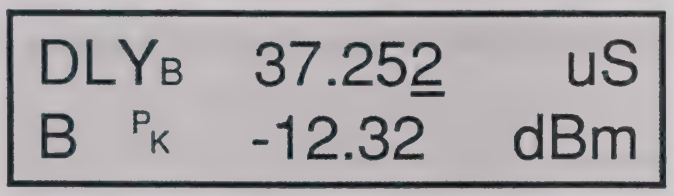


Figure 3b. Channel B Default Sample Delay Display

The default displays will also be used when the meter is Preset.

The default for two sensors will display power readings on both lines as shown in Figure 3c, below:

Figure 3c. Channels A & B Default Sample Delay Display

If a sensor is uncalibrated, the word "UNCALIBRATED" will be displayed for the channel as shown below in Figure 3d:

Figure 3d. Sample Delay Display With Uncalibrated Sensor

The default display will be presented after attachment of a new sensor.

Sample delay offsets are available for each sensor. The use of a non-zero offset will be indicated by an asterisk between the last digit and the units indication as shown below. The delay displayed is the sample delay *before* the application of any offset.

DLYA 56.354*uS

The Sample Delay display line interacts with the Min/Max display line. If Min/Max is turned on for a line that Sample Delay was tracking, Min/Max will be displayed instead of Sample Delay.

Setting Sample Delay

The sample delay can be set from two "locations" within the menu structure. One location is at the default display where sample delay information is displayed. The other is "down" in the menu structure where the peak sensor setup is configured.

Sample Delay Operation

You will be presented with a display with a decimal point fixed in the display. Normally, four digits are available to the left of the decimal point and three digits to the right as shown below. Leading zeros will be suppressed.

```
XXXX.XXX  uS
```

When the units are set to nS, only one digit will be available to the right of the decimal.

The right and left arrow keys move a cursor that will select a digit or unit to be changed. The cursor will only stop at valid digit or unit locations (as shown below). The cursor will stop under valid blank spaces so that large numbers can be entered quickly.

```
XXXX.XXX  uS
^ ^ ^ ^ ^ ^ ^ ^   ^
```

Valid cursor locations

Pressing the up or down keys will add or subtract 1 to the digit above the cursor. If a digit is incremented up past 9, a carry is propagated to the next higher digit (odometer mode). Similarly, if a digit is decremented past 0, a borrow will be made from the next higher digit. You can decrement the delay to a negative number.

An exception is made when the cursor is moved to the 10ths of nS range. The up or down arrows will change the display in 5/10th nS (1/2 nS) increments. This is the maximum resolution of the sensor.

Pressing the up or down keys while the cursor is under the units display will cycle through the units. You will be offered a choice of nS, uS, or mS. The units display does not wrap around.

The units selected will be used in all displays for the delay for the sensor to which they are assigned.

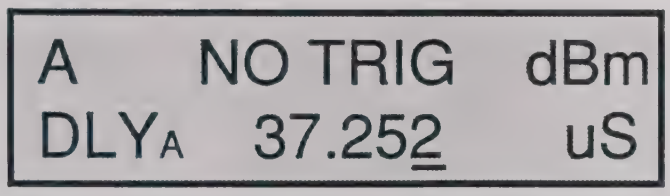


Figure 3e. Sample Delay Display "No Trigger" Indication

If a peak measurement parameter is changed, e.g. sample delay or trigger level, the power display will display a "NO TRIG" message (see Figure 3e above) until a new measurement is made with the new parameters in effect. If the sensor triggers quickly, the message may not be seen. In the TR2 mode, the display may show a MEAS✱ with the asterisk lines rotating as each measurement is made.

The GPIB will return numerical data in the "No Trig" state, depending on the GPIB measurement mode. See the GPIB section discussing Trigger Modes on page 20 for details.

Sample Delay Limits

There is no automatic units scaling for the sample display. You can enter any number up to 9999.999 and then set the units, with the exception of the nS range which allows only one digit to the right of the decimal. If the sample delay plus the offset exceeds the range of the attached sensor, the "S" at the end of the line will be replaced with an arrow indicating an overrange error. An up arrow will indicate that a delay is too high. A down arrow indicates that a delay is too low.

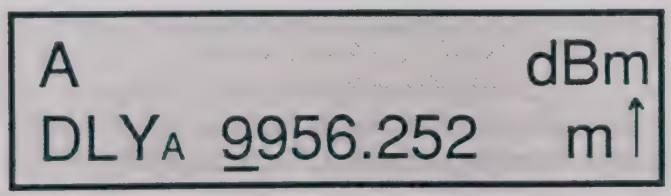


Figure 3f. Sample Delay Display Overrange Indication

When the arrow keys are used to change the units, the digits in the display will simply use the new units. The only exception is going from uS to nS. The digits to the right of the decimal point will be reduced to one digit, and that last digit will be either 0 or 5.

Starting Display	Action	Resulting Display
15.678 uS	↓	15.5 nS

Setting Delay from the Default Display

A cursor will be displayed on the sample delay in the default display.

When you change the sample delay by pressing an up or down arrow key, the associated sensor will be immediately programmed with the new delay. The power display may be replaced with a NO TRIG message until a new power measurement can be made with the new sample delay.

If an overrange sample delay is entered, no measurement will be made until the overrange condition is corrected. (NOTE: Overrange includes delay plus offset.)

If there is more than one delay display line, the left and right arrows will move the cursor "off the end" of one display line and onto the next.

Setting Delay from the Peak Setup Menu

The cursor will be available immediately upon entering this menu.

The sensor will not be updated with the new delay setting until the peak menu sequence is completed. This requires selecting the trigger mode, setting the trigger level, setting the sample delay, and setting the sample delay offset. The display will exit to the default measurement display when the **ENTER** key is pressed on the last menu in the sequence.

Setting Sample Delay Offset

The sample delay offset is settable from the menu following the Set Samp Dly menu (see the Menu Tree on page 6). The method used to enter the delay offset will be the same as the method used to enter the sample delay. You can change a 4.3 set of digits (XXXX.XXX), plus units.

The offset will be range checked together with the sample delay so that the total of sample delay plus offset does not exceed the range of the sensor. If the range of the sensor is exceeded, a beep may sound and an arrow will replace the S at the end of the line (see Figure 3g below) to indicate an out of range condition. If you exit the menu without correcting the out of range condition, no power measurement will be made.

Figure 3g. Sample Delay Overrange Offset Display

For example, if the max delay available from a sensor is 100 mS and the sample delay is set to 75 mS, the maximum offset permitted is 25 mS. Anything larger will cause an arrow to be displayed.

Each sensor has its own delay offset parameter.

Single Peak Sample Measurements

Measurements for a peak sensor will be performed over a number of single samples. A single sample is defined as follows:

1. The sensor is armed.

2. A pulse is triggered and sampled by the sensor. The sensor informs the meter via handshaking that a measurement voltage is available.

3. The meter measures the voltage and computes the power from this one trigger sample.

When averaging is turned on, the averaging will be done over a number of single samples. Auto averaging will use an increasing averaging number as the power level being measured declines. For example, the number of samples required for measurements at 20 dBm is 1. At -20 dBm, the number of samples will be about 32 (this could change depending on mode or software version).

Real Time Pulse Profile and Sample Position Display

The "Detector Out" connector on the rear of the 80350A Series Peak Power Sensor can be connected to any common oscilloscope for a real-time (delayed by about 120 ns) amplitude profile of your signal. (NOTE: The use of a digital oscilloscope can permit better viewing of data.) There are two small markers injected onto this waveform. The first is a small triggering marker which is added slightly after the trigger point. The second marker on the waveform is the sample marker. The sample marker is located slightly behind the actual sample point. There may be small markers at the end of the sample transfer and when the trigger signal occurs. Because the visibility of these markers varies greatly with signal level and horizontal sweep rate, the use of the SAMPLE DELAY output is recommended.

Connect the SMB to BNC cables to your oscilloscope (digital scope preferred - especially for sample delay setting >500 µs) as shown in Figure 4 below.

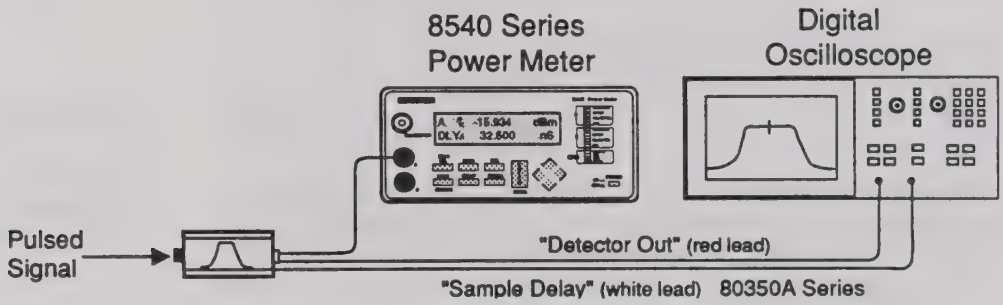
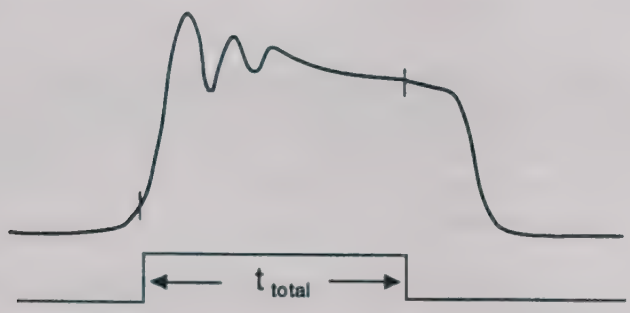


Figure 4. Pulse Profile and Sample Delay Display Test Setup

Use the "Sample Delay" output as an oscilloscope trigger source. This waveform rises at the trigger point and falls at the sample point; thus, it provides both a stable scope trigger source and a precise indicator of the trigger point and sample point.

The time length of the sample delay pulse is the sum of the sample delay which is displayed on the 8540 Series meter's front panel, and the sample delay offset which is available through the menu.



t_{total} = sample delay + sample delay offset

t_{total} = 200.000 µs + 0.120 µs = 200.120 µs

or

t_{total} = 200.000 µs + (-0.010 µs) = 199.990 µs

Figure 5. Sample Delay and Sample Delay Offset Timing Controls

Sample Delay Offset

In addition to compensating for delay line triggering variations or external triggering cables, sample delay offset can be used to set a 0.0 ns time reference point after the trigger point (see Figure 5, above).

In Figure 6, below, triggering occurs at the frame start of a pulsed TDMA communications signal. The trigger level is set such that triggering can only occur on the highest amplitude pulse; this provides stable triggering. A sample delay offset is used to set a 0.0 ns reference point at the start of the third data burst pulse.

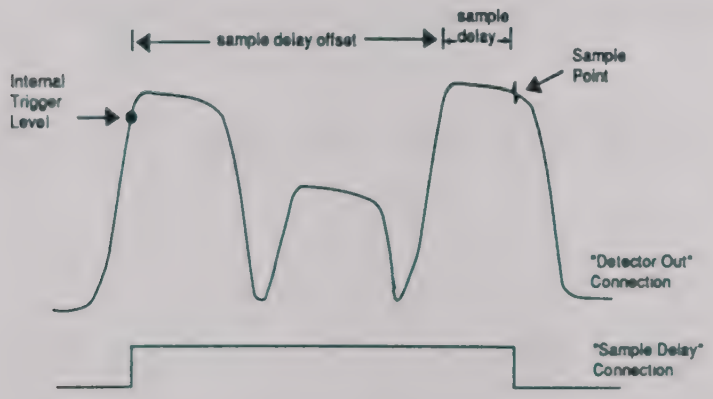


Figure 6. Using Sample Delay Offset to set a 0.0 ns Time Reference

Measuring Pulse Droop

Pulse characteristics such as droop, ripple, and overshoot can be measured quickly using referenced measurements. This involves the use of the front panel REL key for 8540 Series Universal Power Meter users, or the CALC#:REF:COLL function for 58542 VXI Power Meter users.

1. Connect an 80350A Peak Power Sensor to the power meter and the CALIBRATOR output.

2. Calibrate the sensor to the meter by pressing the **CAL/ZERO** key.

3. Upon successful completion of power sweep calibration, connect the sensor to a pulsed signal source. The power level must be above the trigger level.

4. Connect the 80350A's "Detector Out" and "Sample Delay" leads to a digital oscilloscope.

5. Set the sample delay, "DLYA", to the t_1 position just after the rising edge as shown in Figure 7, below.

6. Press the **REL** key. The display should now read approximately 0.00 dBm or 100%.

7. Set the sample delay to the t_2 position just before the falling edge of the pulse.

The display is now reading the pulse-top amplitude variation.

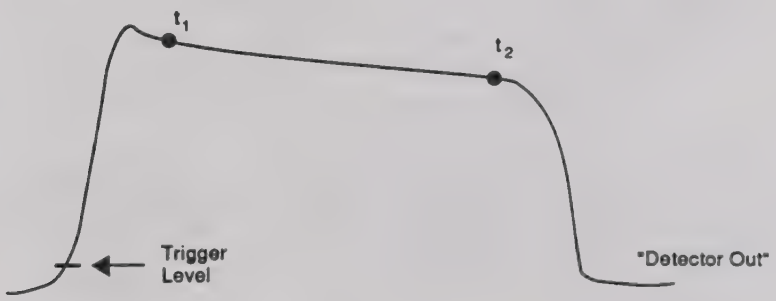


Figure 7. Sample Delay Setting for Measuring Pulse Droop

Measuring 3 dB Pulse Width

Pulse width and other pulse timing parameters can be measured using the REL key and the sample delay offset control. (See Figure 8 on the next page.)

1. Preset the delay offset to 0 nS.

2. Set the sample delay equal to about half the pulse width.

3. Press the **REL** key to set the 0.0 dB (100% for Watts display) reference level.

4. Set the sample delay to a position on the rising edge of the pulse. Increment or decrement the sample delay value until the power level display reads approximately -3.00 dBr.

5. Remember or write down the sample delay value.

6. Press the **MENU** key, and use the up/down arrow keys until *SETUP MENU* is displayed. Press the **ENTER** key to select *SETUP MENU*. Similarly, select *PEAK SNSR SETUP*. Select the current triggering method, *INT* or *EXT*. When *DLY Offset* appears, set the offset value to the same time value from Step 4. This sets the 3 dB down time point to a 0.0 ns reference position.

7. Press **ENTER** to return to the measurement display.

8. Set the sample delay to a position on the falling edge of the pulse. Increment or decrement the sample delay value until the display again reads approximately -3.00 dBr.

The sample delay currently displayed is the signal's 3 dB pulse width.

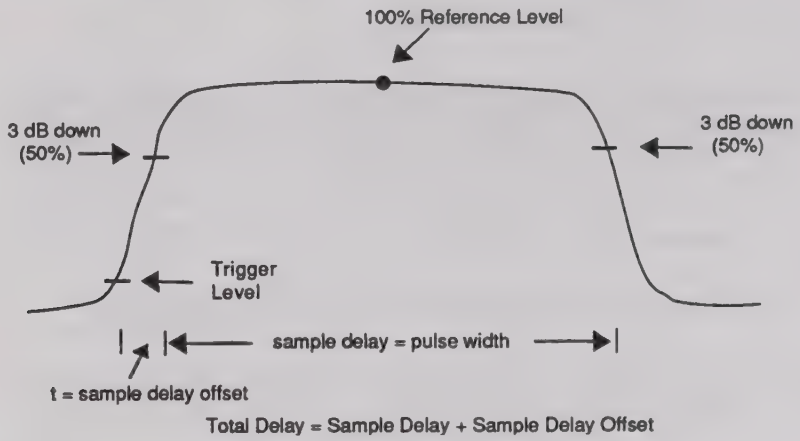


Figure 8. Using Sample Delay to Measure 3 dB Pulse Width

Measuring 10% to 90% Rise Time

Rise time measurements can be performed using a technique similar to the pulse width measurement. This example uses a linear, Watts, display readout rather than the more common logarithmic, dBm, readout to facilitate convenient identification of the 10% and 90% levels.

1. Preset the delay offset to 0 nS.

1. Press the **dBm/mW** key to obtain a linear, Watt, display readout.

2. Set the sample delay equal to about half the pulse width.

3. Press the **REL** key to set the 100% reference level.

4. Set the sample delay to a position on the rising edge of the pulse. Increment or decrement the sample delay value until the power level display reads approximately 10%.

5. Remember or write down the sample delay value.

6. Press the **MENU** key. Select *SETUP MENU*. Select the *PEAK SNSR SETUP*. Proceed to the "Sample Delay Offset" selection. Set the offset value to the same value from Step 5.

7. Return to the measurement display, and increment the sample delay until the display reads approximately 90%.

The sample delay currently displayed is the 10% to 90% rise time.

GPIB COMMANDS

These commands are provided as a supplement to the commands given in the 8540 Series Universal Power Meter Operating and Maintenance Manual.

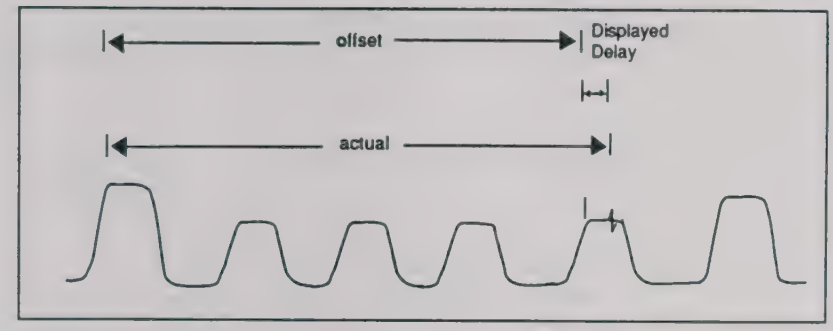
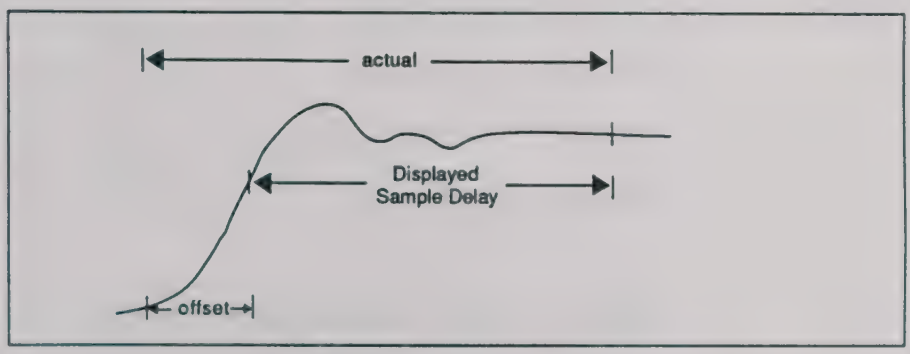


Figure 9. Using Sample Delay Offset to Set a 0.0 ns Reference on a Pulse in a Multi-Pulse Waveform



SAMPLE DELAY OFFSET

$$SD_{Actual} = SD_{Display} + SD_{Offset}$$

Figure 10. Using Sample Delay Offset to Set a 0.0 ns Reference at a Specific Point on a Pulse's Rising Edge

Setting Trigger Modes

```
OUTPUT 713;"PEAK A INT TRIG -10.00"
                                    ! Configure sensor A for internal
                                    ! trigger at -10.00 dBm trigger
                                    ! level

OUTPUT 713;"PEAK B EXT TRIG 1.50"
                                    ! Configure sensor B for external
                                    ! trigger at 1.50 VDC trigger level

OUTPUT 713;"PEAK A CW"              ! Configure sensor A for CW
                                    ! measurements
```

These commands set the trigger method for the 80350A sensor. The sensor can be set to trigger on the rising RF envelope of the power signal. This is the internal trigger mode. An external TTL trigger can be used, or the sensor can "free run" and allow a CW measurement mode with no trigger required.

Trigger Modes WIth a Peak Sensor

```
OUTPUT 713;"TR3"                    ! Last measured value will be
                                    ! returned
OUTPUT 713;"TR2"                    ! Refill averaging buffer *
                                    ! before measurement display
OUTPUT 713;"TR1"                    ! Wait for trigger before
                                    ! returning measurement
OUTPUT 713;"TR0"                    ! Measure, but no display
```

TR0 The meter will measure power, but the display of measured data will be suppressed and the GPIB bus will not be updated with measurement data.

TR1 This mode will wait until the sensor triggers before returning a measurement. The measurement returned will be after the application of any averaging. The display for the channel will follow the TR1 mode. When TR1 is received over the bus, the message NO TRIG will be displayed until the sensor has triggered and measurement data is available.

* The terms "digital filter" (as used in some instrument instructions) and "averaging buffer" (as used here) are interchangeable.

TR2 This mode will wait until enough measurements are made to completely refill the averaging buffer. The measurement returned will be the average of all measurements in the buffer. A message may be displayed (MEAS ✱ with the asterisk lines moving with each measurement) while the averaging buffer is being filled.

TR3 The last measured value will be returned. This mode will not wait for the peak sensor to trigger.

Setting Delays

```
OUTPUT 713;"PEAK A DELAY 1.20E-6"
                                ! Configure sensor A for a
                                ! delay of 1.20 µs

OUTPUT 713;"PEAK B DELAY 33.5E-9"
                                ! Configure sensor B for a
                                ! delay of 33.5 ns
```

When the sensor is configured for internal triggering, the delay from trigger to measurement sample must be set. The valid range of delays is -20 ns to 104 ms, expressed in a floating point number. The smallest delay increment is 0.5 ns. Setting delays in CW trigger mode are invalid and ignored.

```
OUTPUT 713;"PEAK A OFFSET 1.00E-6"
                                ! Configure sensor A for a delay
                                ! offset of 1.00 µs
```

The offset command is used to add a known offset to the trigger delay value. The actual value of delay would be the "DELAY" set plus the "OFFSET" set. The default value of offset is 0. The valid range of offset is -20 ns to 104 ms, expressed in a floating point number.

Reading Values

```
OUTPUT 713;"PEAK A?"          ! Query the current sensor A
                              ! trigger setting
ENTER 713;TRIG$
```

This command is used to query the trigger mode setting of the sensor, and will return:

"CW"
or
"INT_TRIG"
or
"EXT_TRIG"

```
OUTPUT 713;"PEAK A DELAY?"  ! Query the current sensor
                            ! A delay setting
ENTER 713;Delay

OUTPUT 713;"PEAK B OFFSET?" ! Query the current sensor
                            ! B offset
ENTER 713;Offset
```

These commands are used to read the current settings of delay or offset.

PEAK POWER SENSOR GPIB COMMANDS USED WITH THE MODEL 58542 VXI UNIVERSAL POWER METER

SENSe<sensor 1 or 2>:TRIGger:SOURce<INTernal|EXTernal|CW>

This command sets the sensor (1 or 2) peak trigger mode to either the INTernal, EXTernal, or CW mode. (See page 3-82 of the Model 58542 VXI Power Meter Operating and Maintenance Manual for description.)

SENSe<sensor 1 or 2>:TRIGger:DELay[:MAGnitude]<1e-6, -20e-9, 104e-3>

This command sets the sensor (1 or 2) peak delay value to any desired time from -20e-9 to 104e-3 seconds, with 1e-6 seconds being the default setting. (See page 3-83 of the VXI Power Meter manual for description.)

SENSe<sensor 1 or 2>TRIGger:OFFSet[:MAGnitude]<0, -20e-9, 104e-3>

This command sets the sensor (1 or 2) trigger offset time to any desired value from -20e-9 to 104e-3 seconds, with 0 seconds being the default setting. (See page 3-84 of the VXI Power Meter manual for description.)

SENSe<sensor 1 or 2>TRIGger:LEVel[:MAGnitude]<-10 dBm, -30 dBm, 20 dBm>

When the INTernal trigger mode is in use, this command is used to set the trigger level to any desired power level setting from -30 to +20 dBm. Default is -20 dBm. (See page 3-83 of the VXI Power Meter manual for description.)

SENSe<sensor 1 or 2>TRIGger:LEVel[:MAGnitude]<1.700, -0.100, 5.000>

When the EXTernal trigger mode is in use, this command is used to set the trigger level to any desired voltage level from -0.100 to 5.000 volts. Default is 1.700V. (See page 3-83 of the VXI Power Meter manual for description.)

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PERFORMANCE VERIFICATION TESTS

INTRODUCTION

Information in this section is useful for periodic evaluation of the performance and/or receiving inspection testing of the 80350A Series Peak Power Sensors. These tests assume that the operation of the particular 8540 Series Power Meter or Model 58542 VXI Power Meter being used with the sensor has already been verified as described in the power meter's Operating & Maintenance Manual. Verifying the Frequency Cal factors stored in the sensor EEPROM is not described in this procedure. If necessary, the Cal Factors can be verified with a Vector Network Analyzer using similar procedures as for standard power meter sensors.

Before starting these tests, connect the Peak Power Sensor(s) to the 8541/2 meter, and allow it (them) to warm up for at least 24 hours. These tests will only be valid if the power meter and the sensor(s) have been calibrated at an ambient temperature between +20°C and +30°C (+68°F to +86°F), and are operating within ±3°C (±5.4°F) of the calibration temperature.

Equipment Required

Description	Representative Instrument	Key Requirements
Power Meter	Giga-tronics 8540 Series (or VXI)	Compatible with 8035XA Sensor
RF Source	Wavetek Model 2510 (Hi Power Opt.)	+20 dBm @ 50 MHz
Oscilloscope (DSO)	LeCroy 9400	Bandwidth 125 MHz
CW Thermistor Power Meter	HP Model 432B	Inst. Acc. of at least 0.5%
Thermistor Mount	HP 478A-H75	0 to +10 dBm range <1.1 SWR
Pulse Generator	Wavetek Model 278	Delay & Pulse width control
Attenuators 10, 20, 30, and 40 dB	Weinchel Model AC118A-90-33	Type N, 0.5 dB accuracy VSWR <1.20 @ 50 MHz
Directional Coupler	Narda Model 3002, 10 dB	
Low Pass Filter	Integrated Microwave Model 904 881	>50 dB Atten. @ 100 MHz

POWER LINEARITY TEST

The linearity will be tested in a series of 10 dB steps over the range of the sensor. At low power levels, the measurements will reflect the uncertainty due the noise and zeroing specifications. Make a copy of the Performance Verification Data Sheets on pages 31 and 32 to record the data from this test.

CW LINEARITY

1. Connect the test setup as shown in Figure 11, below. Set the RF source to 50 MHz. Be sure the sensor has had at least 24 hours of warm-up time. To take accurate measurements it is essential to take out any drift that might occur.

   a) Calibrate the Peak Power Sensor in the same way as described on page 3-8 of the 8541/2 manual.

   b) The 8541/2 is placed in the CW mode by pressing:

   MENU —> (use arrow keys to select) *SETUP MENU* —> **ENTER** —> (use arrow keys to select) *PEAK SNSR SETUP* —> **ENTER** —> (use arrow keys to select) *CW INT EXT* —> (use arrow keys to select) *CW* —> **ENTER**

   c) Set the 8541/2 to display power in linear units (mW) by pressing **dB/mW**

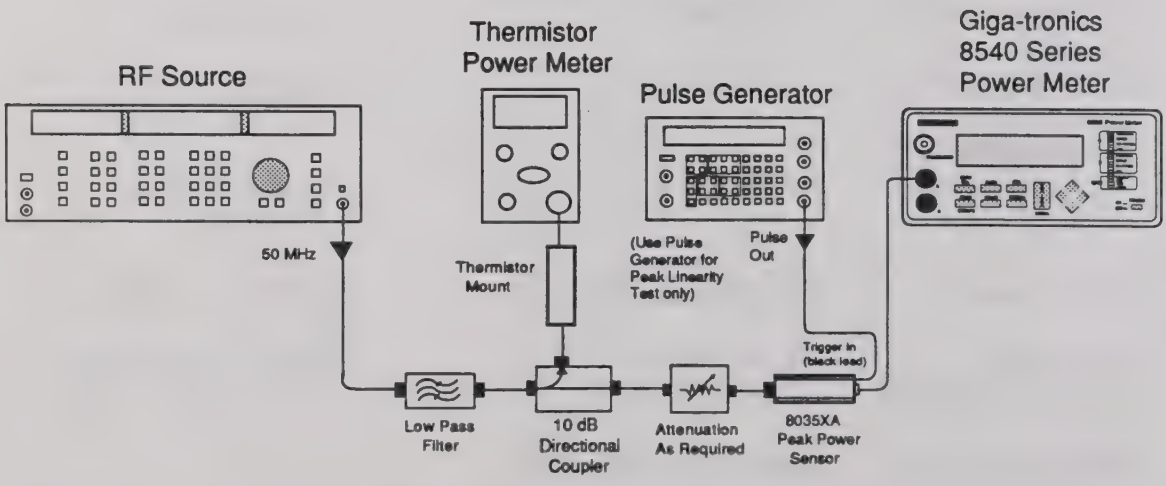

Figure 11. Power Linearity Test Setup

d) Set the Averaging to 4 by pressing **MENU** —> (step to) *AVERAGE* —> **ENTER** —> (step to) **4** —> **ENTER**

e) Set the CW frequency to 50 MHz by pressing **FREQ** —> **.050** —> **ENTER** Likewise, set the source frequency to be 50 MHz.

2. Start with no attenuation between the coupler and the Peak Power Sensor. Record results on the first row of the linearity data recording sheet.

3. Turn the RF power from the source off. Zero the Peak Power Sensor by pressing **ZERO/CAL**

4. Zero the thermistor power meter.

5. Turn the RF source on.

6. Adjust the RF source until the thermistor power meter reads 10.0 mW ±0.25 mW.

7. Record the thermistor power meter reading, P1, and the 8541/2 reading, R1, on the data sheet.

8. Adjust the RF source until the thermistor power meter reads 1.0 mW ±0.025 mW.

9. Record the power meter reading, P2, and the 8541/2 reading, R2, on the data sheet.

10. Calculate and record the reference power ratio P1/P2, and the DUT reading ratio, R1/R2.

11. Calculate and record the Linearity Error using the formula:

$$\text{Linearity error (\%)} = [(R1/R2)/(P1/P2) - 1] * 100$$

12. Add an additional -10 dB of attenuation between the coupler and the Peak Power Sensor and repeat Steps 3 through 9, filling in the 10 dB through 40 dB (through 30 dB in Peak Mode) attenuation rows of the data sheet. On these rows, add the current linearity error to the accumulated linearity error in the row above. Verify that this accumulated error is less than the specified values given on the data sheet.

PEAK LINEARITY

Set the sensor to EXT, 1.7V, 10 µs, 0 offset, and connect the TRIGGER IN (black lead) to the pulse generator. Set the pulse generator to 1 kHz, and repeat Steps 1 through 12 as given in the CW Linearity Test for this Peak Linearity verification test. (Select *EXT* Trigger Mode in Step 1.b instead of *CW*.) Record the readings on the Peak Linearity Data recording sheet on page 32.

TRIGGER MODES TEST

Connect the test setup as shown in Figure 12. Set the pulse generator for a 100 Hz pulse repetition frequency. Set the RF source to make a 2 µs wide pulse. Set the 8541/2 to display power in linear units (mW). Set the source to a frequency of 50 MHz with a power level near 0 dBm.

1. Initially set the delay of the pulse generator to 0 µs. Set the Peak Power Sensor to the EXT mode by repeating Step 1.b on page 26, only selecting *EXT* instead of *CW*. Then select:

   ENTER —> 1VDC —> ENTER —> 1 µS —> ENTER —> 0 µS —> ENTER

   Set EXT Trigger. Set the top line of the display for "A", and the bottom line for "DLYA" (see Figure 3 on page 8). Set the delay for 1 µs. Check that the Sample Delay width is at 1 µs ±25%.

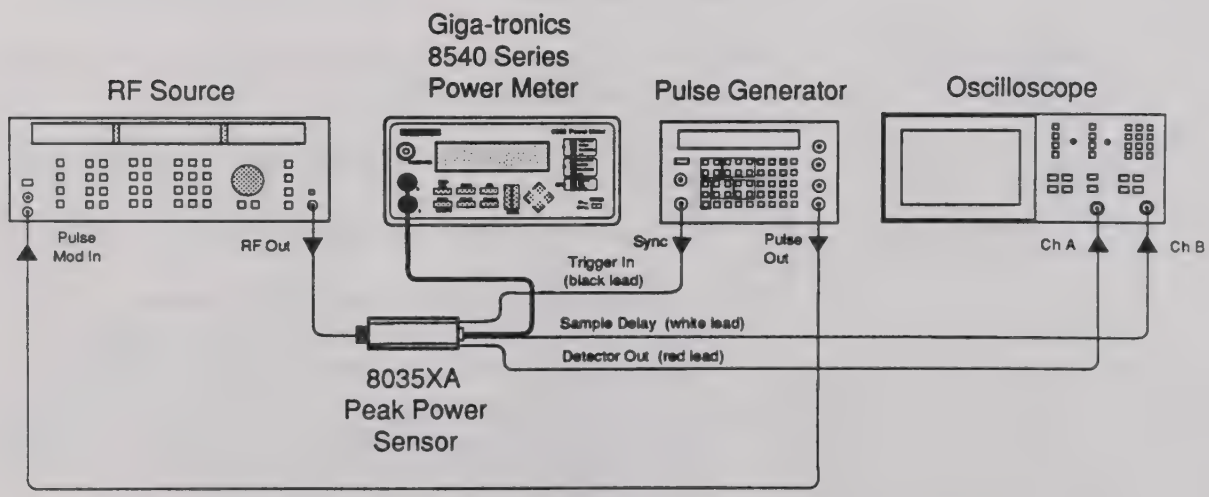

Figure 12. Trigger Modes, Detector Output and Trigger Level Test Setup

80350A Series Peak Power Sensors Operating and Maintenance Manual

Manual Correction

On page 29, the table under Step 4 of the Delay Test procedure should be replaced by the table shown below:

Delay Setting	Width Measured at 1.7 V	
	Lower Limit	Upper Limit
-20 ns	10 ns	30 ns
60 ns	40 ns	110 ns
1 µs	900 ns	1100 ns
10 µs	9 µs	11 µs
100 µs	90 µs	110 µs
1 ms	900 µs	1100 µs
100 ms	97 ms	103 ms

DETECTOR OUTPUT TEST

Leave the test setup as shown in Figure 12. Connect the 1MΩ oscilloscope input to the Detector Output. Verify that the pulse has an amplitude of approximately 600 mV peak to peak for a 0 dBm signal.

TRIGGER LEVEL TEST

1. Set the INTernal trigger delay to 10 µs and trigger level to 0 dBm. Set the input pulse amplitude to 10 dBm. Verify triggering by noting that the sample delay pulse is present.

2. Set the trigger level to -10 dBm. Set the input level to 0 dBm and verify trigger operation. Set the input level to -20 dBm and verify triggering does not occur.

3. Set the external trigger to 1.7VDC. Verify triggering with +5V TTL peak pulse input, and no trigger with the EXT TRIG IN

DELAY TEST

The Upper and Lower Limits shown below are the minimum tolerances to test Delay functionality.

1. Connect sensor to channel A of the 8541/2, allow to warm up for 24 hours, and then calibrate the sensor.

2. Press **RECALL**, select *PRESET*, and press **ENTER**.

3. Connect sensor to a pulse generator with a 0 dBm, 50 MHz, 2 µs pulse.

4. Using an oscilloscope or a frequency/width counter, measure the pulse width of the SAMPLE DELAY output at the following settings:

Delay Setting	Lower Limit	Upper Limit
-20 ns	10 ns	30 ns
60 ns	40 ns	80 ns
1 µs	900 ns	1100 ns
10 µs	9 µs	11 µs
100 µs	90 µs	110 µs
1 ms	900 µs	1100 µs
100 µs	97 µs	103 µs

CONCLUSION

This completes the Specification and Performance Verification Tests for the 8035XA Peak Power Sensor. If the Sensor has performed as described in the preceding tests, it is functional and correctly calibrated.

If the sensor fails to meet the criteria defined in these tests, refer to the Maintenance and Troubleshooting sections of this manual starting on page 43, or contact your local Giga-tronics Sales Representative for assistance.

GIGA-TRONICS 80350A SERIES SENSORS PERFORMANCE VERIFICATION TEST DATA RECORDING SHEET

Date: _____

Model 8035_A:
Peak Power Sensor S/N: _____

Operator: _____

Test Number: _____ (if required)

CW Linearity Data

Step Attenuator Value	Power Set Point	Power Meter Reading (P)	8541/2 Reading (R)	Power Ratio	Reading Ratio	[1] Linearity Error (%)	
						[3] Linearity Specification	[2] Accumulated Linearity Error
0 dB	10.00 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4%	*Same as Lin. error above*
10 dB	10.0 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4%	
20 dB	10.00 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4%	
30 dB	10.00 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.0 mW ±0.025 mW	P2 =	R2 =			±4.5%	
40 dB	10.00 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.00 mW ±0.025 mW	P2 =	R2 =			±9%	

(continued on next page)

[1] Linearity Error (%) = [(R1/R2) / (P1/P2) - 1] * 100
[2] Accumulated error is the sum of the current 10 dB segment linearity error plus the previous accumulated error.
[3] System linearity + power meter uncertainty + zero settability

Peak Linearity Data

Step Attenuator Value	Power Set Point	Power Meter Reading (P)	8541/2 Reading (R)	Reference Power Ratio	8541/2 Reading Ratio	[1] Linearity Error (%)	
						[3] Linearity Specification	[2] Accumulated Linearity Error
0 dB	10.00 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.00 mW ±0.025 mW	P2 =	R2 =			±4%	*Same as Lin. error above*
10 dB	10.00 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.00 mW ±0.025 mW	P2 =	R2 =			±4%	
20 dB	10.00 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.00 mW ±0.025 mW	P2 =	R2 =			±4.5%	
30 dB	10.00 mW ±0.25 mW	P1 =	R1 =	P1/P2 =	R1/R2 =		
	1.00 mW ±0.025 mW	P2 =	R2 =			±9%	

[1] Linearity Error (%) = [(R1/R2) / (P1/P2) - 1] * 100
[2] Accumulated error is the sum of the current 10 dB segment linearity error plus the previous accumulated error.
[3] System linearity + power meter uncertainty + zero settability

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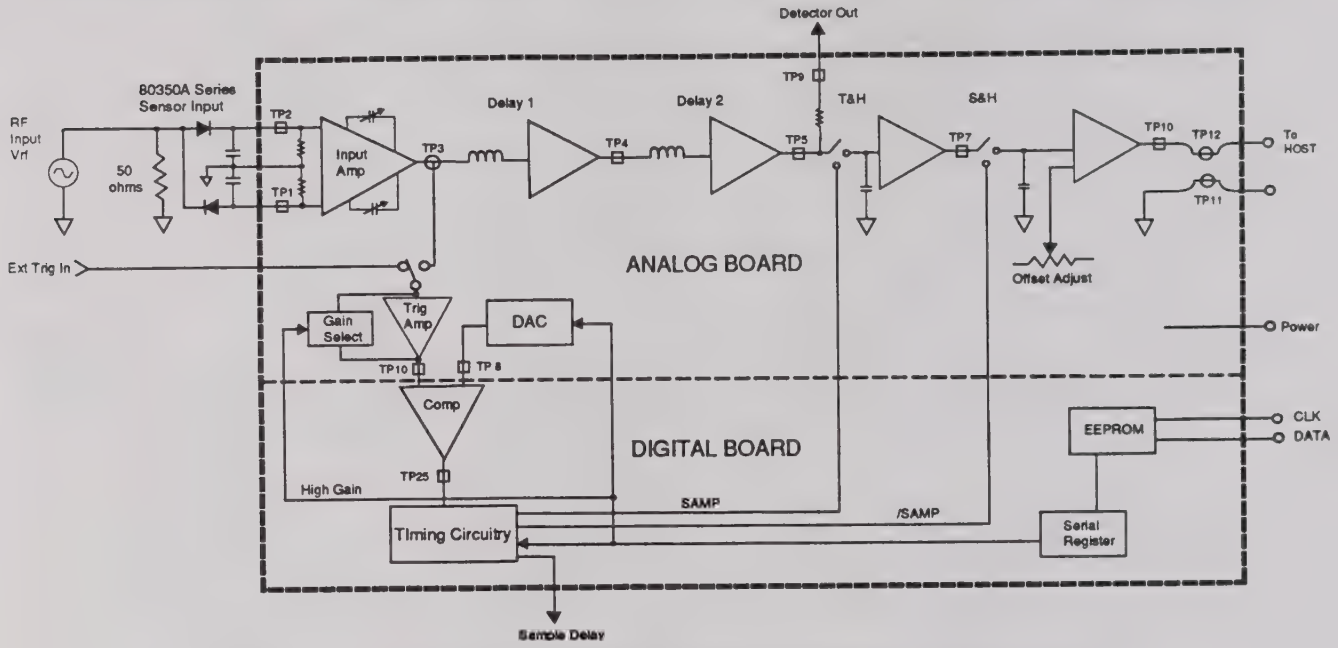

Figure 13. 80350A Series Peak Power Sensor High Level Block Diagram

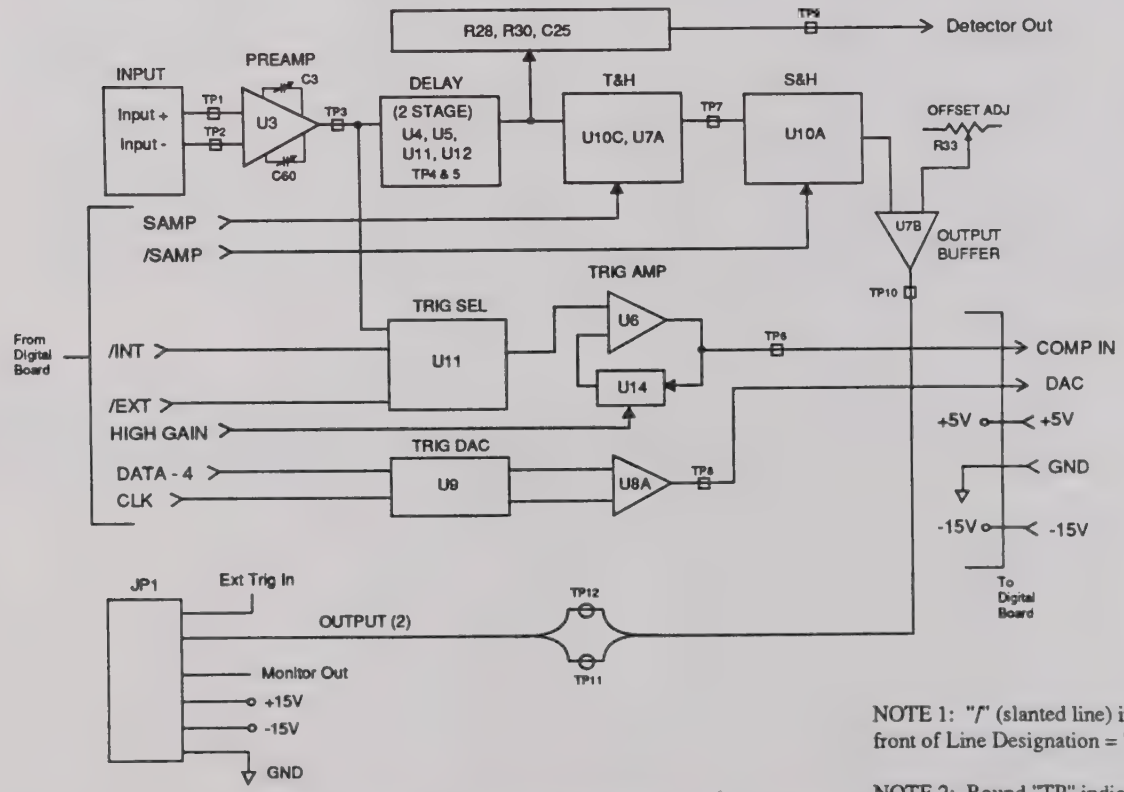

Figure 14. Analog PC Board Block Diagram

NOTE 1: "/" (slanted line) in front of Line Designation = "NOT"

NOTE 2: Round "TP" indications on the diagrams mean standing pins on the PC board; square "TP" indications mean flat pads on the board.

ELECTRICAL DESCRIPTION

GENERAL

Refer to Figure 13, Block Diagram on page 34, to follow the general function of the sensor. The RF signal is rectified in the sensor element, and the video envelope is buffered and delayed by the input amplifier and delay buffers. This buffered envelope is available at the "Detector Out" connector. The track & hold (T&H) tracks and follows the signal, and then holds it for hundreds of microseconds. The sample & hold (S&H) acquires the output of the track & hold, and holds it for hundreds of milliseconds.

The timing circuitry generates the sample pulses from the trigger input or, if the sensor is in the free run mode, from an internal oscillator.

Note that the block diagrams, the schematics, the circuit descriptions, and the troubleshooting information in the Maintenance section are all written around the circuit test points. Please observe the delay lines shown in Figure 13 and illustrated in the Analog Timing Diagram, Figure 15, on the next page. Note the use of delay lines to match the delay through the analog channel to the sample point, and the delay through the timing circuitry to the sample generator. Since fixed "lumped constant" delay lines are used, the match is not perfect. Also, notice that the delay through the INTernal trigger is slightly longer than the delay through the EXTernal trigger due to the delay of the input differential preamp.

ANALOG PC BOARD

Refer to Figure 14 on page 34, the Analog Timing Diagram (Figure 15) on page 36, and Schematic Diagram #21351 on page 61 to follow the discussion of the Analog PC Board's circuit operation.

The rectified signal from the detector goes into the resistors R1 or R2 (TP1 & 2). The signal sees 2K to ground from either input. (The negative input sees 2K to a virtual ground inside R100.) R3 helps to balance the input bias current. U1 and U2 delay the signal so the trigger output and video output may be viewed close together. U4 and U5 are buffers for the delay lines (TP3).

U10C and U7A provide a fast Track and Hold (T&H). U7A buffers the T&H capacitor, C21, and U7B buffers the S &H capacitors, C1 & C2.

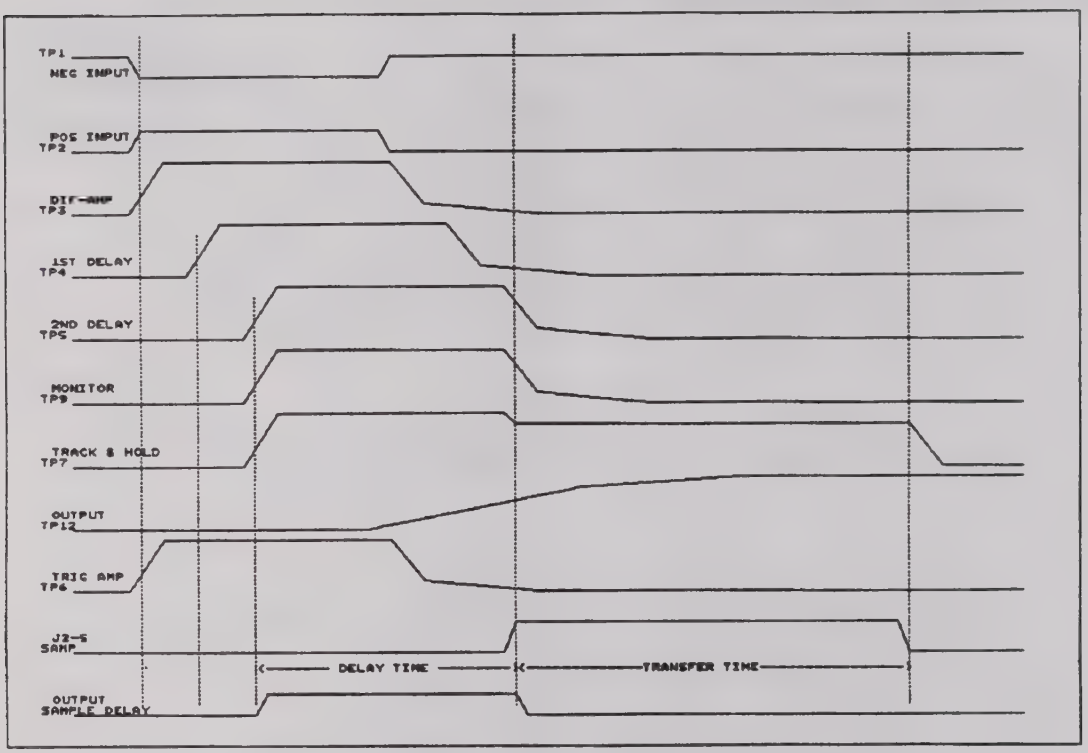

Figure 15. Analog Circuit Timing Diagram

NOTE: All times shown in Figure 15 are referenced to TP3, and are not to scale.

A track and hold differs from a sample and hold in the manner in which the signal prior to the hold is manipulated. In a sample and hold the sample gate turns on, the holding capacitor is charged to the signal potential, the sample gate turns off, and the hold capacitor maintains the value of the input at the time of the sample. In a track and hold circuit the voltage on the hold capacitor is the same as the input (tracks) until the track gate goes off, after which the level is held until the track goes on and the hold capacitor again follows the input.

The trigger source is selected, either INTernal or EXTernal, by U10D & U11A. U11B functions as an invertor for HIGHGAIN. U6 amplifies the trigger signal by 1 or 41. Trigger DAC U9 is loaded with a count from the serial chain. The DAC needs the data signal held for at least 80 ns. Digital board A2R12 and A2C25 take care of that requirement. That count gets translated into a voltage between -0.1V and about +5V by U8A. Digital board comparator A2U18 provides the TRIG-IN pulse (A2TP25). A2R42 provides hysteresis for A2U18.

DIGITAL PC BOARD

(Refer to Figure 16, Block Diagram on page 38, the Digital Timing Diagrams (Figures 17a/b and 18) on pages 40, 41, and 42, and the Schematic Diagram #21354 on page 65 to follow the discussion of the Digital PC Boards' circuit operation)

Overview

The digital board provides the timing functions that allow for delays between a small negative time (with respect to either the video monitor, or the sampled pulse) and >100 ms. In the CW mode, the digital board is not reset, but continues to generate clocks and samples at about 70 µs intervals. In either the INTernal or EXTernal modes, an acquisition is requested by the host ("host" means the power meter to which the sensor is connected) which causes READY to be set. When an input trigger is received it is latched and delayed by a FINE delay, and then starts a 10 MHz clock. This clock increments a COARSE counter until it reaches "FFFFF" or all ones, and then outputs an RCO (Ripple Carry Out) signal. This is latched as SAMPle, delayed by one count, and then compared to the count of 51 µs out of the counter to allow the SAMPle to be 51 µs wide. Then the COARSE counter is reLOAD-ed for about 5 µs, the 10 MHz clock stopped for about 5 µs, the /LOAD unasserted, and the TRIGger, SAMPle, and READY flip-flops reset for about 1 µs. A 48 bit serial stream provides the 80350A configuration information. When the serial clock is running, CLKHOLD resets the TRIG loop and loads the counter.

Operation

When READY (TP17) is true, U8B flip-flop (TP14 - TRIG) is set after TRIG-IN goes high. U13 delays the TRIGgered signal by a delay programmed in 1/2 ns intervals. U3 is a 10 MHz gated delay line oscillator which, when enabled by the fine delay, clocks (TP1) the coarse counter U16, U15, U6, U1, and U5, and the SAMPLE flip-flops U7B and U8A. (Unlike conventional gated oscillators which free run, a gated delay line oscillators' beginning time period is the same length as all of its other time periods with the possible exception of the last period when enable is unasserted.) When RCO (TP8) is true for one clock cycle (ignores pulses less than 100 ns), U7B is latched as SAMPle (TP11). SAMPle is delayed by one count [because 51 µs (TP7) can still be true when SAMPle goes true], ANDed with 51 µs from U1, and when true (when SAMPle has been on for 51 µs), U10A, loader receives a negative edge clock. /LOAD for the COARSE counter is asserted and held low via U9C, R34, and C27 until the 10 MHz clock, U3, stops via U12A, U10B, (TP9), U4A, and U4C. Note the sequence:

1. CTR-CLK (TP1) must be running.

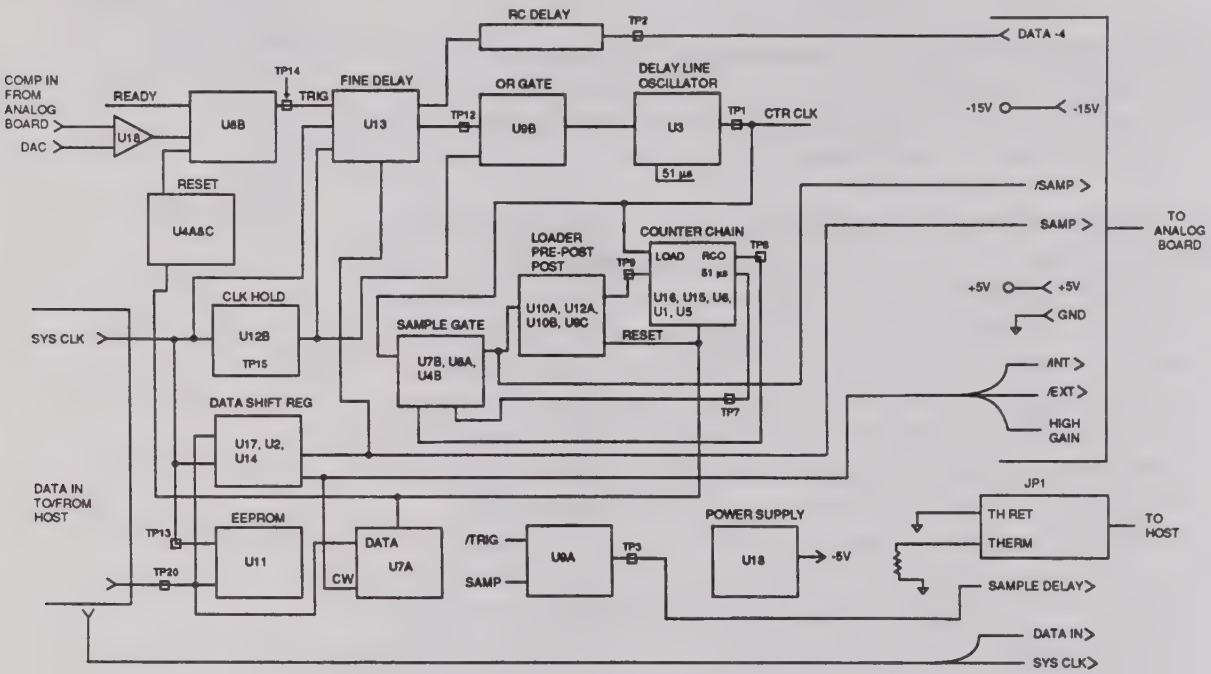

Figure 16. Digital PC Board Block Diagram

NOTE: "/" (slanted line) in front of Line Designation = "NOT"

2. /LOAD-CTR (TP9) goes low and stays low while CTR-CLK continues for at least one cycle. (This loads the COARSE counter.)

3. CTR-CLK (TP1) stops. /LOAD-CTR is still low. (CTR-CLK continues in the CW mode.)

4. /LOAD-CTR returns high (at least 200 ns) before /POST (TP5) returns high.

Note that the same FINE delay which delayed the start of the 10 MHz clock now works against turning the 10 MHz clock off.

SAMP (TP11) going high turns the TRACK AND HOLD to Hold on the ANALOG board, and turns the SAMPLE AND HOLD to Sample. When it goes low, the TRACK AND HOLD goes back to tracking the input and the SAMPLE AND HOLD holds the sampled signal level. U10B POST (TP5), the major reset circuit, resets READY (TP17) to prevent the trigger circuit from restarting, continues to reset TRIG (TP14) (except in the CW mode) which

started in PRE-POST, and resets SAMP (TP11). When the host has read the data, the DATA-IN line is momentarily pulsed low by the host which sets READY (TP17), and pulls the DATA-IN line (TP20) low via diode CR3. Note that the DATA-IN --- READY handshake does not occur in the CW mode.

EEPROM U11 stores the sensor type, serial number, and calibration constants. This IC is only accessed by the host. Except for device start and stop conditions, DATA-IN can change states only when CLK is low. After device stop has been sent, the host sends a 48 bit serial stream to set up the 80350A sensor. Four zeros are sent, followed by the 12 DAC trigger bits, followed by the fine counter 8 bits, 20 bits for the COARSE counter (with FFFFF meaning zero delay), and finally the 4 control bits (INTernal, EXTernal, CW, and HIGHGAIN). Because the serial DAC on the ANALOG board has a data hold requirement of 80 ns minimum, DATA-4 (TP2) must be delayed by R12 and C25.

Incoming CLK turns on U3 (10 MHz - TP1) and U9C (/LOAD) (TP9) via U12 (CLKHOLD) which loads the COARSE counter with the new delay.

Please note that the test points are essentially in order across the length of both the Analog and Digital boards in the approximate order of signal progression to aid in troubleshooting. In addition, the between-the-board connectors can be used as test points.

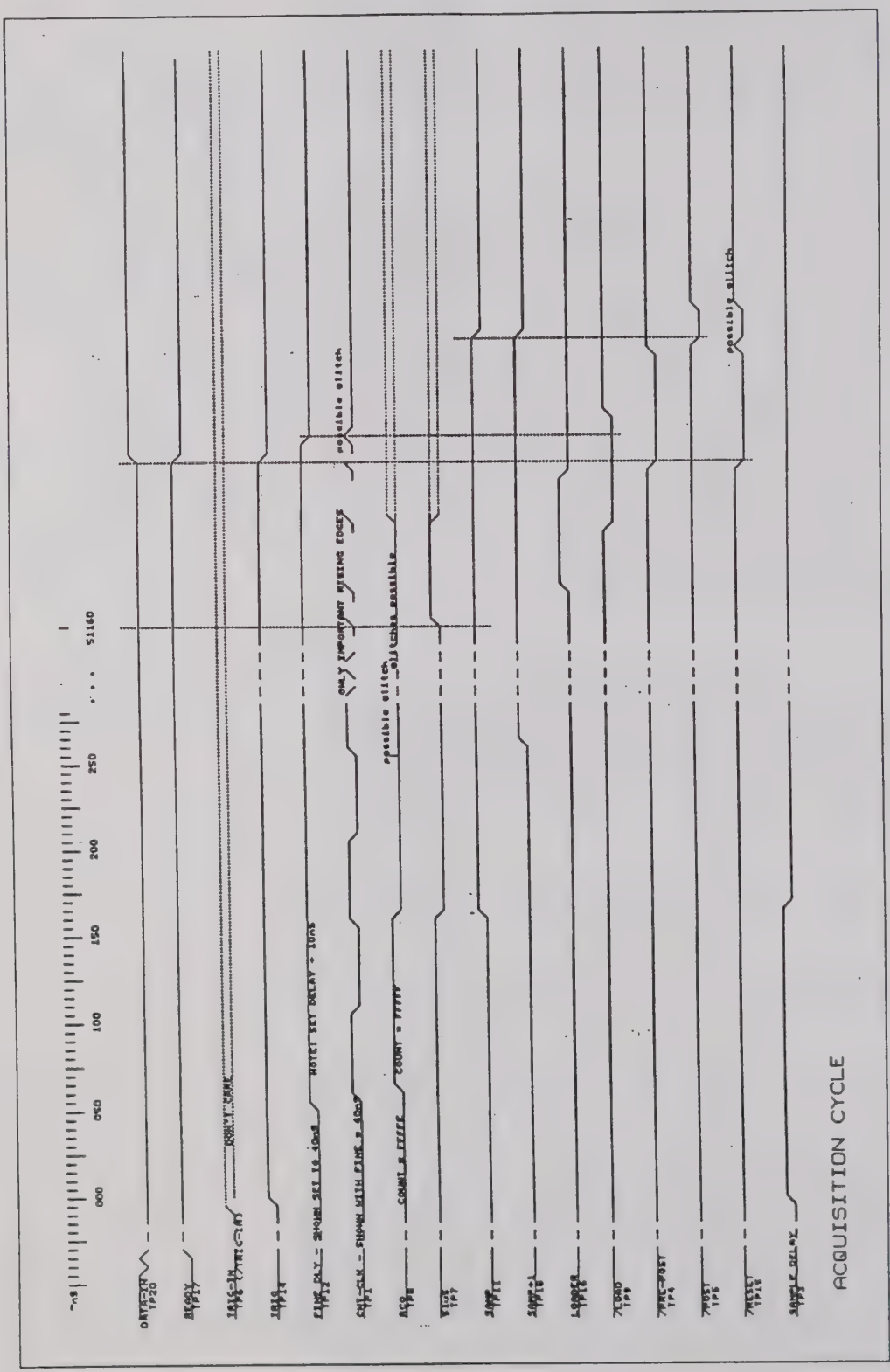

Figure 17a. Digital Circuitry Acquisition Cycle Timing Diagram - INT / EXT Triggered Mode

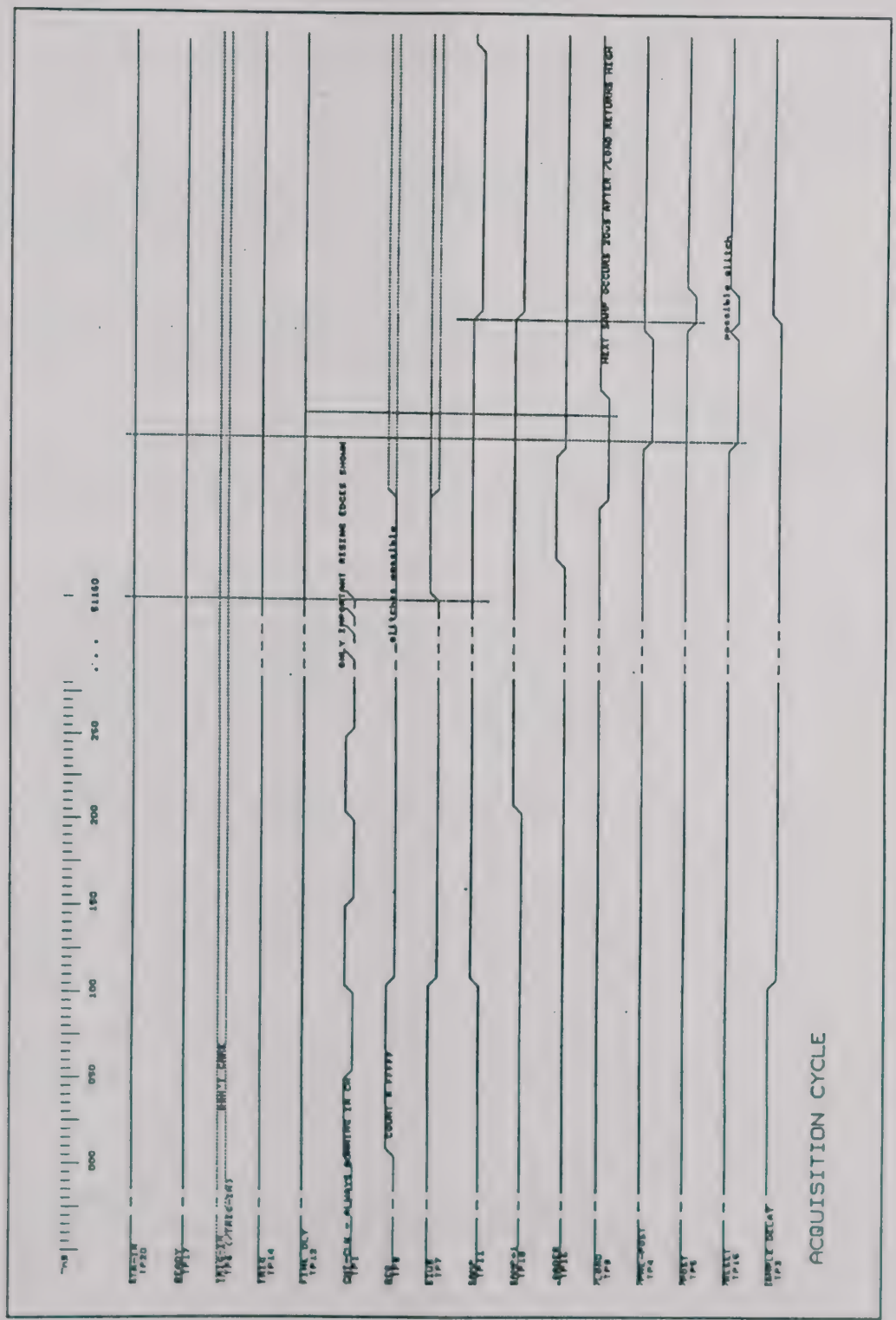

Figure 17b. Digital Circuitry Acquisition Cycle Timing Diagram - CW Mode

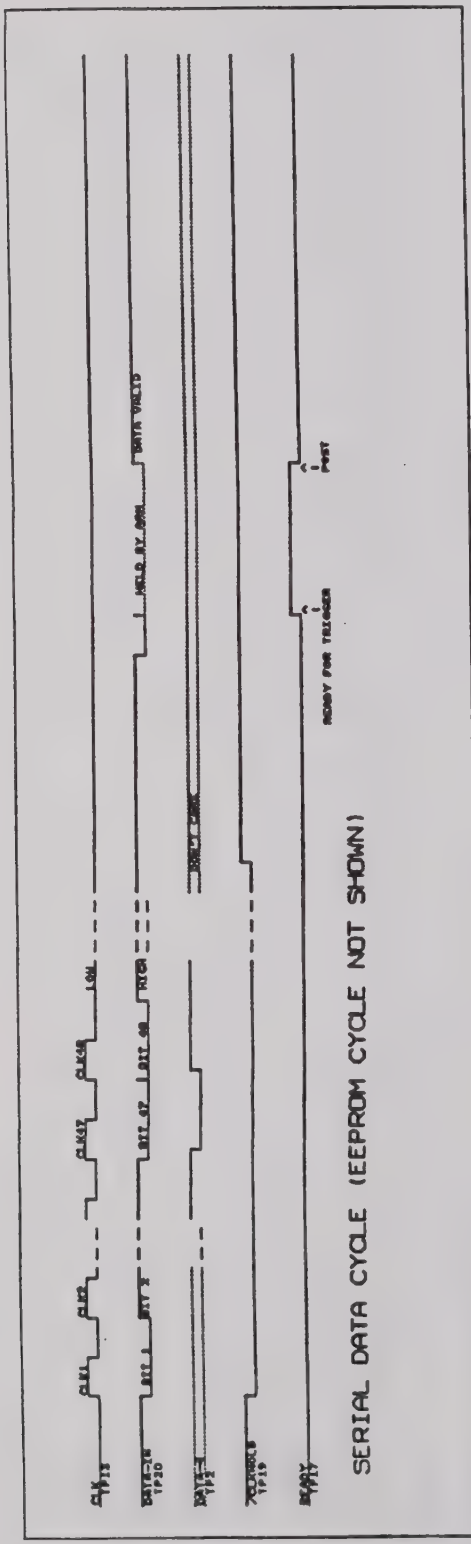

Figure 18. Digital Circuitry Serial Data Cycle Timing Diagram

MAINTENANCE

There is no regularly scheduled maintenance required for the Peak Power Sensors.

MAINTENANCE CALIBRATION

Utilizing the normal Operation Calibration procedure described at the beginning of the Operation Section on page 5 will ensure that the sensor is operating within its specified linearity.

At six month or one year intervals, it is recommended that the sensor risetime, overshoot, and zero be calibrated as follows.
(Always allow at least 30 minutes warmup time before testing.)

Rise Time Adjustments

It is important that the rise time of the RF pulse be fast (about 10 ns), and without overshoot. Care is necessary to get repeatable results.

Connect the test setup as shown in Figure 12 of the Performance Verification Test procedure on page 28. Set the pulse generator for a 5 kHz pulse repetition frequency. Set the RF source to make a 2 µs wide pulse. Set the 8541/2 to display power in mW. Set the source to a fixed frequency at a power level near 10 dBm. Set the RF frequency to 50 MHz.

1. Set the delay of the pulse generator to 0 ns. Set the Peak Power Sensor to the delay triggered mode by pressing

   MENU —> (step to) *PEAK SNSR SETUP* —> **ENTER** —> *A* (or B) —> **ENTER** —> *EXT* —> **1.7** —> **ENTER** —> Set Delay to 1 µs —> **ENTER** —> Set Delay Offset to 0.00 —> **ENTER**

   The 8541/2 will read the settled power of the pulse, approximately 10 mW.

2. Press the **REL** key.

3. Increase the delay of the pulse generator to 900 ns. Vary the delay until the maximum power is found. Subtract 100% from this number to calculate the overshoot.

4. Increase the delay of the pulse generator until the reading drops to 90 ±1%. Note this time.

5. Increase the delay of the pulse generator until the reading drops to 10 ±1%. Note this time.

6. Subtract the time noted in Step 4 from the time noted in Step 5. The result is the 10% to 90% power rise time.

7. C3, C59, and C63 are factory select components chosen for optimum risetime, falltime, and overshoot. If it is necessary to change these parts, C59 and C63 should have the same value. The detector out signal on the oscilloscope will indicate the direction of change in the rise time and overshoot, but is not suitable for quantitative measurements. For best results, profile the pulse by stepping the measurements using small (about 10 ns or less) delay increments.

Zero Adjustment

1. This test requires that no RF is present, and that the instrument is in the CW mode. Be sure that the system is allowed to warm up at least 30 minutes. The measurement should be made quickly to prevent cooling of the circuit.

2. Remove the cover of the sensor and connect a DC millivolt meter between TP11 (Common) and TP12 (High) on the Analog Board.

3. Adjust R33 (OFFSET ADJ) for 0.00 VDC ±100 μV.

4. Replace the cover and calibrate the sensor.

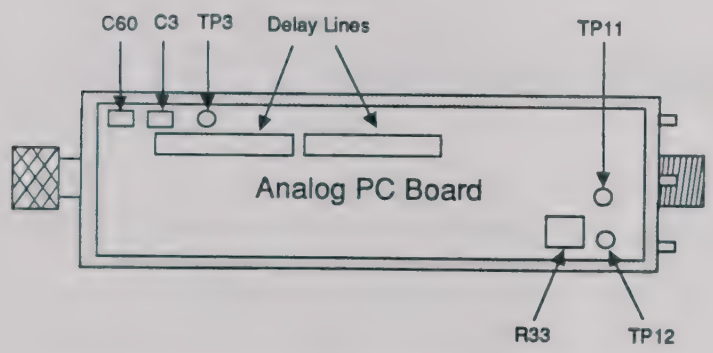

Figure 19. Principle Test Component Locations

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TROUBLESHOOTING

CAUTION: *STATIC SENSITIVE COMPONENTS.* USE PROPER TECHNIQUES INCLUDING, BUT NOT LIMITED TO, WRIST STRAPS, ANTI-STATIC MATS, TOOLS, SOLDERING IRONS, DESOLDERING TOOLS, AND PROPER NON-STATIC CLOTHING. STATIC DAMAGE TO COMPONENTS MAY NOT BE DETECTABLE FOR UP TO A YEAR, DEGRADING READING ACCURACY AND POSSIBLY REQUIRING EXTENSIVE REPAIRS OR COMPLETE REPLACEMENT.

GENERAL

Please refer to the Analog and Digital PC Board schematics on pages 61 and 65, the block diagrams on pages 34 and 38, and the timing diagrams on pages 36, 40, 41 and 42 for assistance in performing the following procedures

Use a pulsed 1 GHz waveform of about 0 dBm for troubleshooting to trace the signal through the sensor. The waveform should have a rep rate of about 1 kHz, pulse width about 100 µs to start, INT trigger @ -20 dBm, and delay = 0.

At times it may be required to carefully check voltages at IC pins. Since the PC boards are surface mount, careless probing can: short two pins, break leads, damage boards and, in extreme cases, cause the components to break away from the board taking pads and traces with them. ***PLEASE USE ALL POSSIBLE CARE!!!***

The most common cause of failure is the application of too much power (more than +23 dBm) which destroys the diode element. This will most likely manifest itself as a non-successful completion of the sensor calibration routine. (see the beginning of the Operation Section on page 5). Verifying that another sensor will calibrate successfully will isolate the fault to the Peak Power Sensor and not the instrument.

A1TP1 should measure about -0.2V, and A1TP2 should measure about +0.2V with a 0 dB CW input. If either of these voltages are absent, the element is probably bad and should be replaced.

TROUBLESHOOTING PROCEDURES

The following table lists problems that can occur with the sensor in the logical order that these problems might become evident. Go to the first described symptom, and then follow the instructions given in the section covering that symptom. Symptom descriptions assume that everything preceding that symptom in the table is functioning properly.

SYMPTOM	SECTION (and location)
Sensor isn't recognized as being present	A. **SENSOR NOT PRESENT** (below)
Won't calibrate / zero	B. **CALIBRATION** (next page)
INTernal won't trigger or level error	C. **INTernal** (page 50)
EXTernal won't trigger or level error	D. **EXTernal** (page 51)
Delay error	E. **DELAY** (page 52)
MONITOR OUT / or SAMPLE DELAY output error	F. **OUTPUTS** (page 52)

Please Note:

In these procedures, the component prefix "A1" designates parts located on the ***Analog*** PC Board. The prefix "A2" is for parts located on the ***Digital*** PC Board.

Also:

Voltage levels at MONITOR OUT and at test points are referred to as "approximate" or "about". These values can vary widely from sensor to sensor. To ensure that proper levels are present, increase or decrease the measured input or trigger level. The measured point should change correspondingly.

Also:

Certain supplies (A1U3, 4, 5, 6, and A2U18 and A2 5V line) are isolated by 10 ohm resistors which decouple noise and can act as fuses. If one of these resistors (A1R108, 109, 110, 111, or 112, or A2R42 or A2R45 is open, replace the corresponding tantalum capacitor: A1C51, 52, 53 54, or A1C30 or A2C19.

A. SENSOR NOT PRESENT

Note that this type of failure indication is usually caused by a bad cable or a faulty temperature sensing thermistor (RT1).

1. With the sensor disconnected from the power meter, check the resistance from Digital board J1 pin 4 to ground. Is it about 10K?

NO	YES
A2RT1 bad (If A2RT1 must be replaced, be sure to install the new RT1 using heat sink compound. RT1 should protrude 0.13" above the PC board.)	Cable bad

B. CALIBRATION

Calibration failures are generally caused by a damaged diode element. Ensure that the system is in the CW mode. *Steps 1 and 2 refer to the Analog board.*

1. Check for a signal present at MONITOR OUT or A1TP9. (Should be near zero µV with no signal input, and about +3VDC at +20 dBm.)

NO	YES
Check as appropriate, A1TP4, then A1TP5, or A1TP3, A1TP1, and A1TP2. Replace as required (as isolated by test points and supply tests) A1U3, A1U4, or A1U5.	Continue to Step 2

Please Note:

A1TP3, TP4, TP5, and TP6 should be checked for oscillation, especially if drifting occurs.

2. (A1TP9 OK) Check for toggling signal at J2 pins 4 and 5 (SAMP and /SAMP. Toggling?

NO	YES
Continue to Step 3	Check A1TP7, A1TP10, and the DC OFFSET adjustment (A1R33). Note that A1TP10 should be 0 with no signal input, and about 0.6 with +20 dBm. See Zero Adjustment on page 45.

3. (SAMP not toggling) *Refer to the Digital board.* Check TRIG (A2TP14) Is it High?

NO	YES
A2U17, A2U8, A2CR4, or A2R35 bad	Continue to Step 4

4. (TRIG high) A2TP1 toggling? (10 MHz CTR-CLK)

NO	YES
A2U13 (A2TP12), A2U9, or A2U3 bad	Continue to Step 5

5. (A2TP1 OK) A2TP9 high?

NO	YES
A2U9, A2U10, or A2U12B bad	Continue to Step 6

6. (A2TP9 high) A2TP11 stuck high?

NO	YES
A2U7 bad, or the coarse counter A2U1, U5, U6, or U16. Note that A2TP8 and TP10 check the ICs on the back of the board for RCOs (Ripple Carry Outs). Note that the RCOs of the counters will glitch (Ignore pulses less than 50 ns. Adjusting the scope trigger level generally allows glitch rejection.) A pulse of approximately one clock width is necessary for the next stage to count.	A2U10, U12, U1, or U4 Check A2TP16, A2TP5 , and A2TP7

C. INTernal

Internal problems are generally due to trigger problems. A1U9 has a programming peculiarity in that it requires an 80 ns hold time. A2R12 and A2C25 satisfy that requirement. If the DAC appears not to program, check A1CR1 before checking the DATA-4 timing or replacing the IC.

1. Set the trigger level to +20 dBm. Check the voltage at A1TP8. > 4VDC?

NO	YES
A1CR1 A1U6, A1U8, A1R12, or A1C25 bad	Continue to Step 2

2. Set the trigger level to -30 dBm. Check the voltage at A1TP8. < +0.1VDC?

NO	YES
A1U6, A1U8, A1R12, or A1C25 bad	Continue to Step 3

3. Check for pulses (about 4 ±2V peak) at A1TP6 with 0 dB, 1 kHz repetition rate. OK?

NO	YES
Continue to Step 4	Go to Step 5

4. (A1TP6 bad) J2 pin 13 low?

NO	YES
A2U17 or A2R32 bad	A1U10, A1U11, A1U6. Check for (about 400 ±200 mV) pulses at U6 pin 3 (A1U10 bad if not). Else, replace A1U11 or A1U6.

5. Check voltage at A1TP8. Should be about +40 mVDC, about +4VDC with trigger level at +20 dBm, and about 0 VDC with trigger level at -30 dBm. OK?

NO	YES
A1CR1, A1U9, A1U8	Check A2TP17 (READY - should be high) and A2TP6. If A2TP6 does not toggle, replace A2U18. Else, A2U4, A2U12. or A2U8.

D. EXTernal

Check A1R127, A1R128, /EXT (J2 pin 11 - A2U17 bad if /EXT is high), else replace A1U10.

E. DELAY

Delay problems are caused by the coarse counter, the fine delay, or the serial data link. Problems can be grouped by checking in order the delays shown in the table below.

This is a stuck or missing bit test. The next two digit number can be used, such as 26 µs for 25.6 µs, or 3.3 ms for 3.27 ms. The accuracy, while typically within ±2% ±5 ns, only needs to be verified to ±25% to ensure that there are no "stuck bits".

Monitor the width of the SAMPLE DELAY output pulse. This signal is about 40 ns wider than the delay setting. For the first line of the table below, verify that each step is about 25 ns wider than the previous step.

All of the components are located on the Digital (A2) board.

0 ns	U13	25 ns	U13	50 ns	U13	75 ns	U5
200 ns	U5	400 ns	U5	800 ns	U5	1.6 ns	U5
3.2 µs	U6	6.4 µs	U6	12.8 µs	U6	25.6 µs	U6
51.2 µs	U1	102.4 µs	U1	204.8 µs	U1	409.6 µs	U1
819.2 µs	U16	1.6384 ms	U16	3.2768 ms	U16	6.5536 ms	U16
13.1072 ms	U15	26.2144 ms	U15	52.4288 ms	U15	100 ms ±2%	U15

Also check the programming ICs, especially the carry pins (pin 13) of A2U17, A2U2, and A2U14.

F. OUTPUTS

Check A2U9 for SAMPLE DELAY, A1R28 for MONITOR OUT. Also check J1 wiring.

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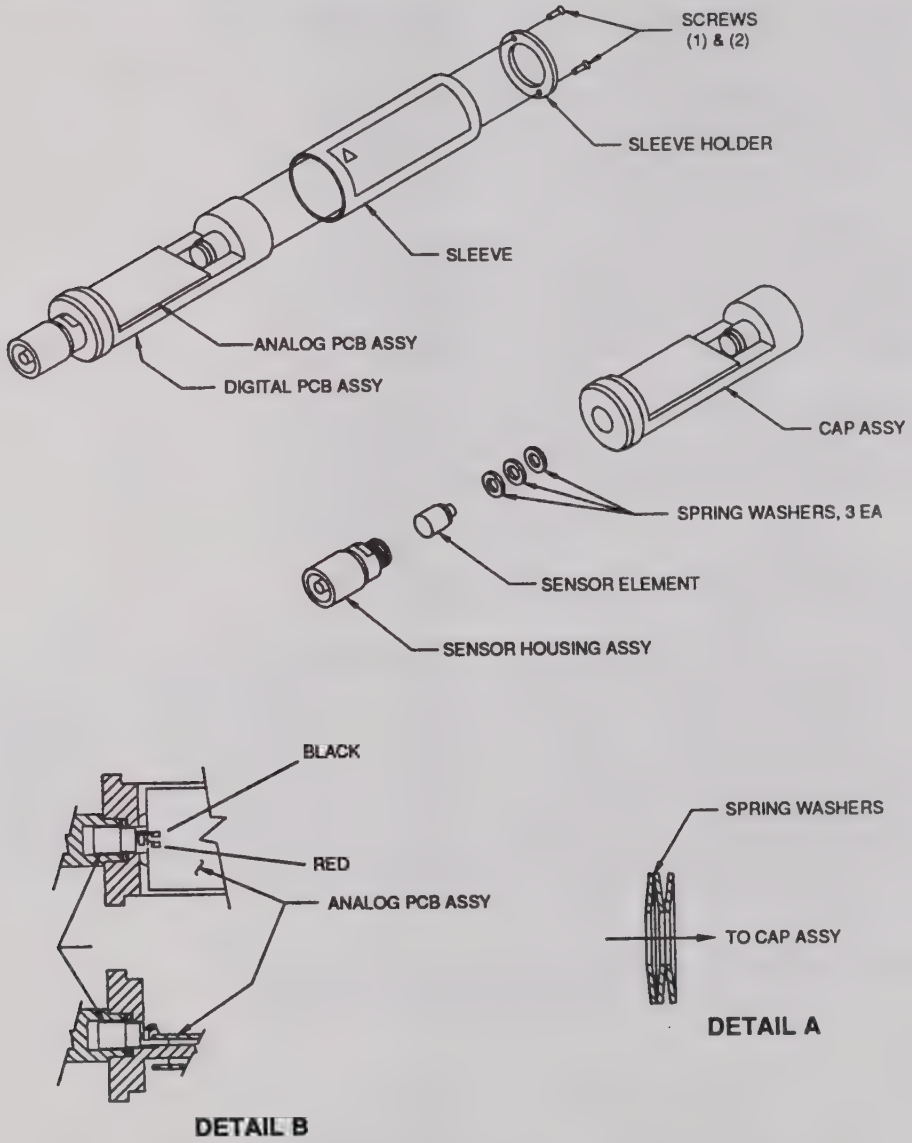


Figure 20. Sensor Disassembly and Reassembly Components

DISASSEMBLY OF SENSORS

(Refer to Figure 20)

CAUTION: Static Sensitive Components. Read the Caution paragraph at the top of page 47.

1. Remove screws (1) and (2). Take off the Sleeve Holder Plate and slide the Sleeve off of the Cap Assembly.

2. Position the sensor so that the Analog PC Board (Assembly #21350) is visible, and locate the Sensor Element leads. They are located on the end of the PC board nearest to the Sensor

Housing Assembly. Remove the solder from the leads of the Sensor Element, and remove the leads from the holes in the PC board. Straighten the leads.

3. Remove the two PC boards.

4. Unscrew the Sensor Housing Assembly from the Cap Assembly. Use the wrench flats on the Housing Assembly which are located closest to the Cap Assembly to remove the Housing Assembly. The Sensor Element will stay attached to the Housing Assembly.

   If the Spring Washers fall out when the Sensor Housing Assembly is removed, they should be replaced as shown in Detail A of Figure 20.

REPLACEMENT OF SENSOR ELEMENT

CAUTION: Removal of the sensor element invalidates EEPROM calibration factors.

(Cal Factors can be verified with a Vector Network Analyzer using similar procedures as for standard power meter sensors.)

1. Remove the old Sensor Element from the Sensor Housing Assembly by pulling the Element straight out from the Assembly. Ensure that the center pin was removed with the element. It not, carefully remove it with a pair of tweezers.

CAUTION: Do not twist the Sensor Element as it is being removed. Doing so could damage the center conductor of the Sensor Housing Assembly.

2. Take the new Sensor Element out of its protective packaging, and carefully straighten the leads. **Do not pull sharply on the leads or they will come off.**

3. Carefully insert the new Sensor Element into the Sensor Housing Assembly. Gently push on the Sensor Element to press the Sensor Element pin into the center conductor contact of the Sensor Housing Assembly. Once the Element has been inserted, gently try to pull it back out of the Housing Assembly. If there is resistance, the Element is inserted correctly. If the Element comes out easily, then the Element has not been correctly inserted into the center conductor. Remove the

Sensor Element, make sure that the center conductor is centered in the Housing, and then reinsert the Element.

CAUTION: Do not twist the Sensor Element while inserting it. This can damage the Sensor Element pin or the Sensor Housing Assembly center conductor.

REASSEMBLY OF SENSORS

(Refer to Figure 20)

CAUTION: Static Sensitive Components. Read the Caution paragraph at the top of page 47.

1. Make sure that the Sensor Element leads are straight. Screw the Sensor Housing Assembly into the Cap Assembly. Be very careful not to damage the leads of the Element.

2. Place the Element leads onto the proper pads on the Analog PC board as shown in Detail B of Figure 20. The lead from the Center pin goes to Pad 1, and the other lead goes to Pad 2. Solder the leads in place.

3. Replace the PC boards. Take care not to damage the sensor element wires.

4. After the Element has been installed, it may be necessary to readjust the pulse response of the amplifier due to a possible difference in the video resistance of the new Element's diodes in relationship to the old Element's diodes. (See the Maintenance Procedure on page 43 for checking and adjustment information.)

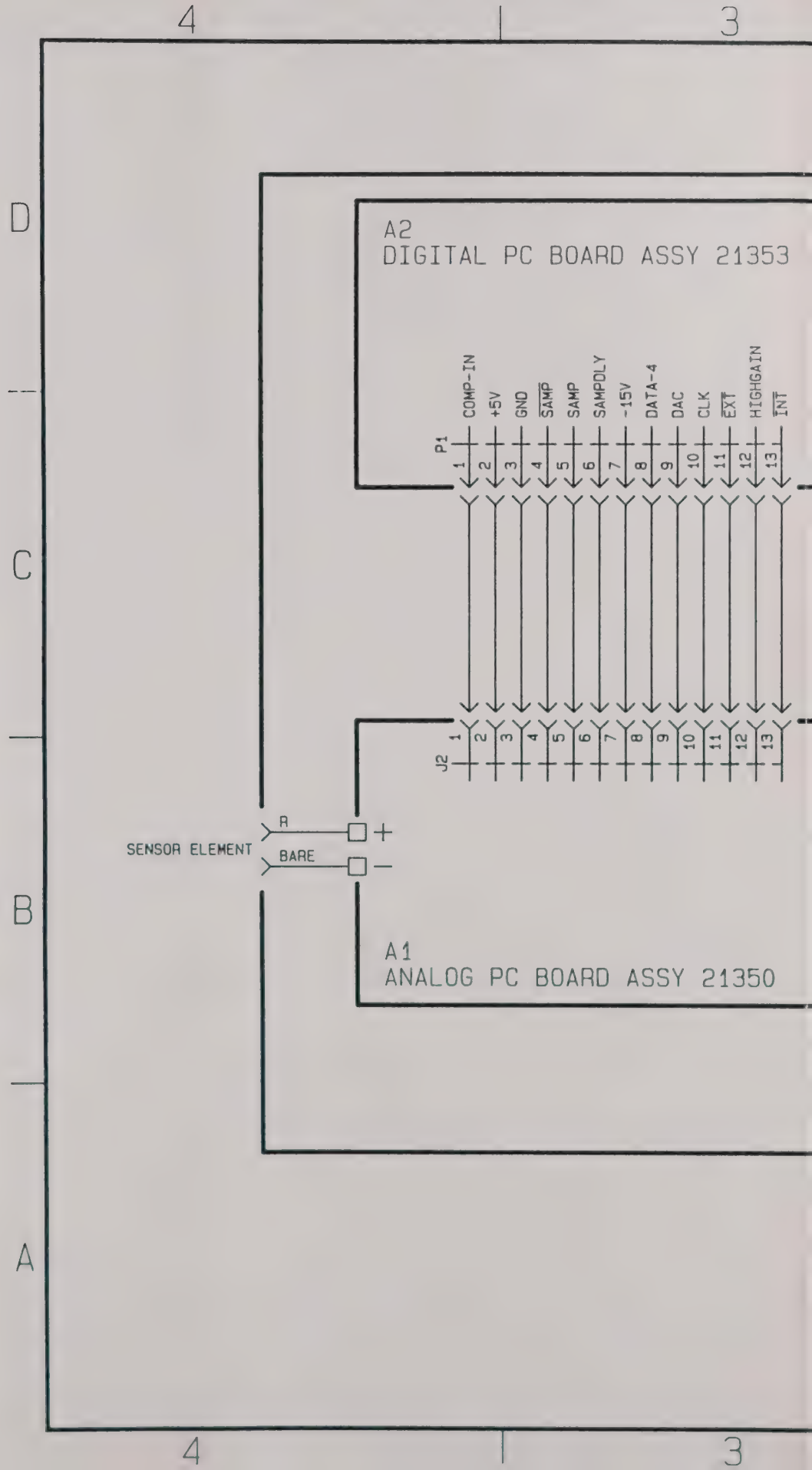
5. Slide the Sleeve onto the Cap Assembly. Replace the Sleeve Holder Plate. Insert and tighten screws (1) and (2), and return the sensor to service.

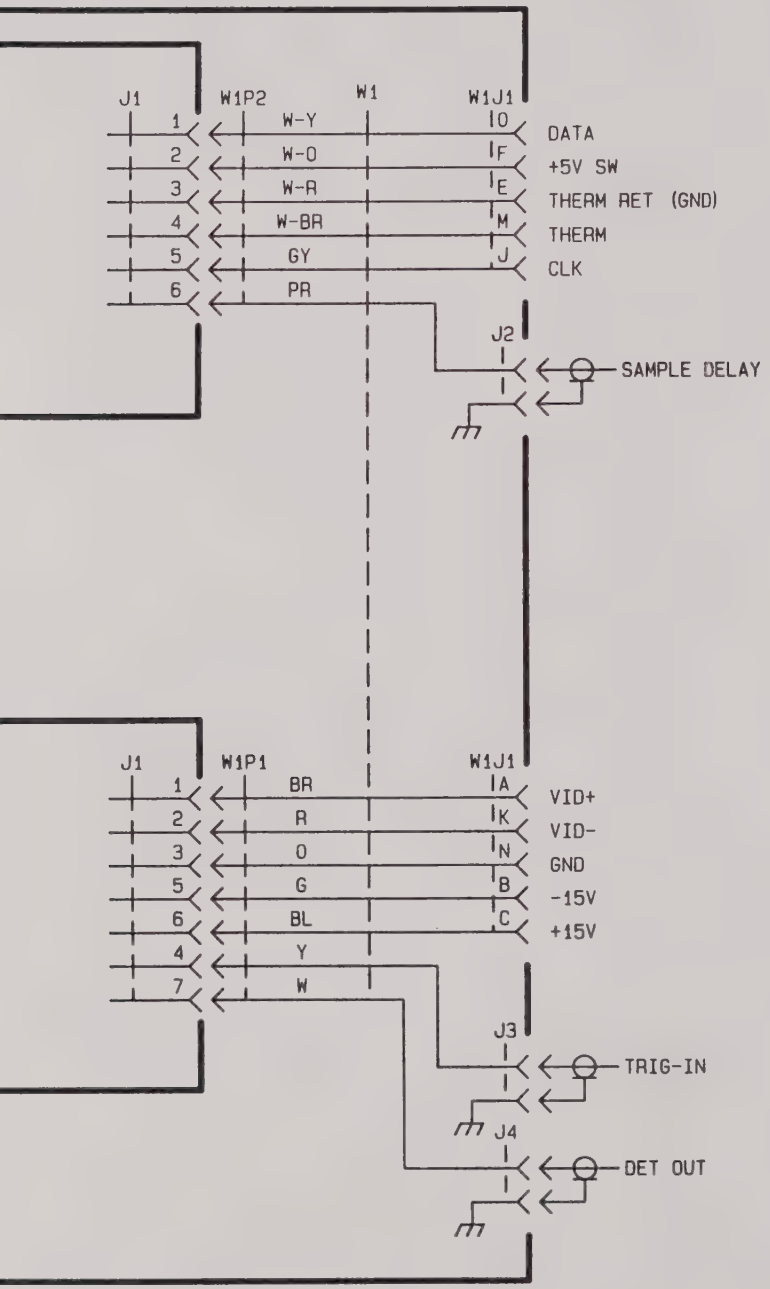
INDEX

Schematic Diagrams (SD) and Assembly Drawings

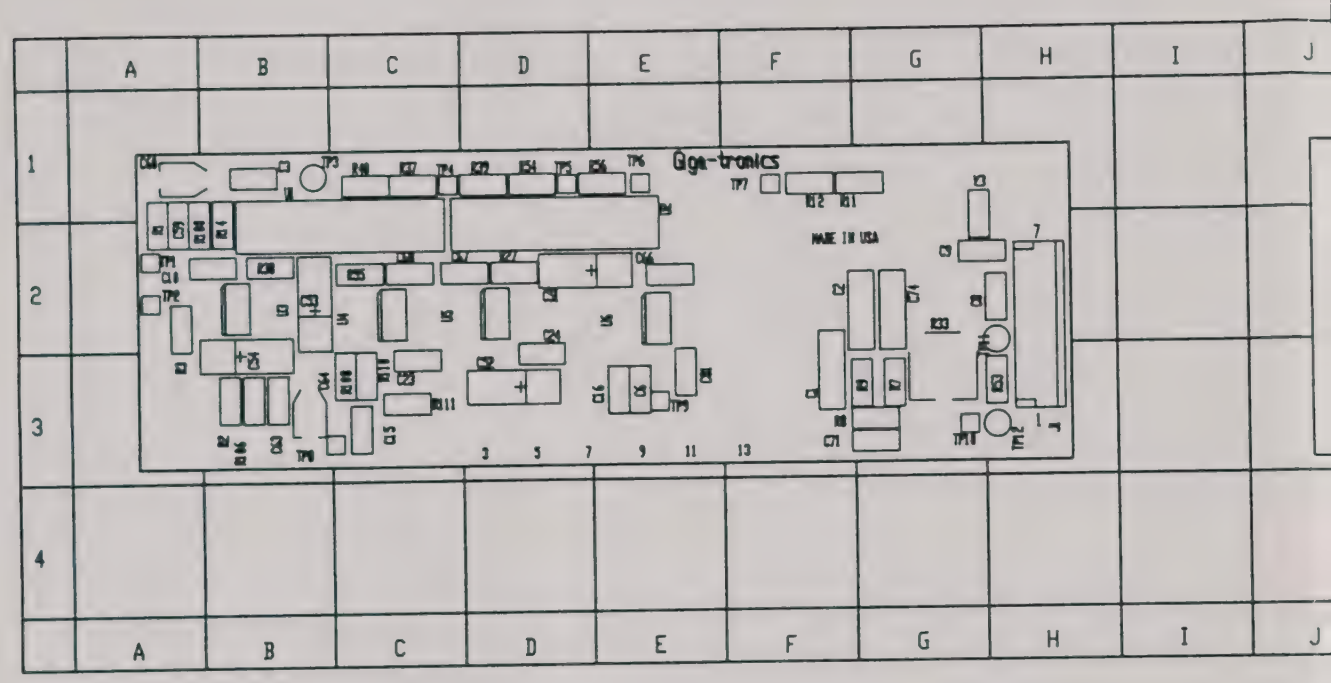
(PC Board Component Parts Locations)

Reference Designation		Drawing Number	Page Number
	80350A Series Sensor SD	21497	59
A1	Analog PC Board Assembly Dwg. (Figure 21)	21350	60
	Analog PC Board SD (2 Sheets)	21351	61
A2	Digital PC Board Assembly Dwg. (Figure 22)	21353	64
	Digital PC Board SD (2 Sheets)	21354	65


4
3
D
C
B
A
A2
DIGITAL PC BOARD ASSY 21353
P1
1 COMP-IN
2 +5V
3 GND
4 SAMP
5 SAMP
6 SAMPDLY
7 -15V
8 DATA-4
9 DAC
10 CLK
11 EXT
12 HIGHGAIN
13 INT
J2
1 2 3 4 5 6 7 8 9 10 11 12 13
SENSOR ELEMENT
R
BARE
+
−
A1
ANALOG PC BOARD ASSY 21350
4
3



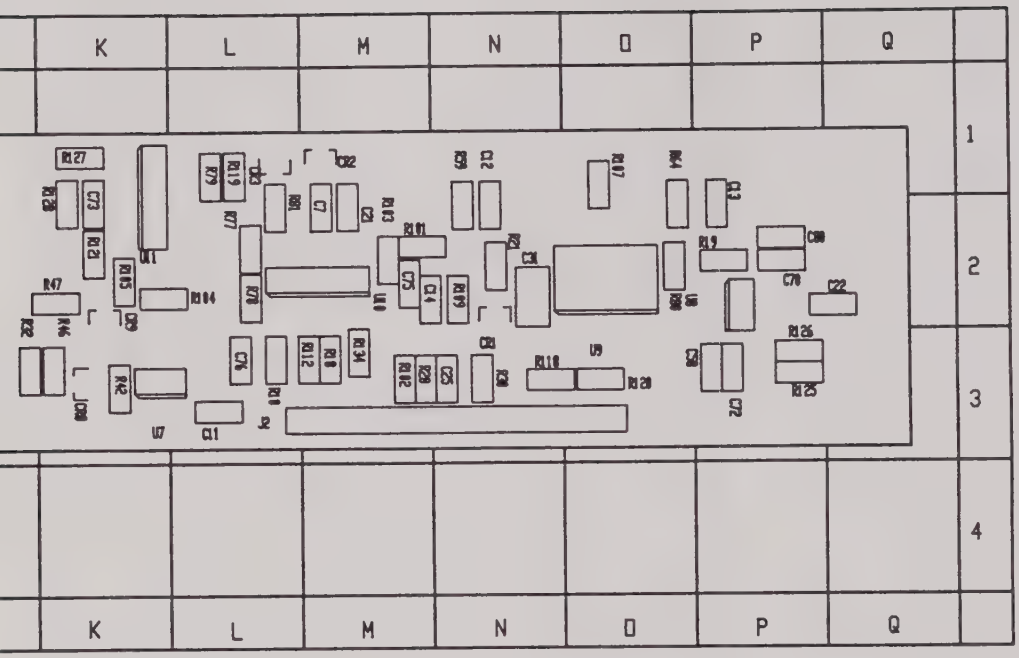
		Giga-tronics
APPROVALS	DATE	SCHEMATIC, 80350 SERIES TRIGGERABLE SENSOR
DRAWN J. BAUER	1-27-93	
CHECKED		
ENG		SIZE C · DRAWING NO. 21497 · REV 1
MFG ENG		SCALE N/A · SHEET 1 OF 1



TOP SIDE

Figure 21. Analog PC Board Assembly (A

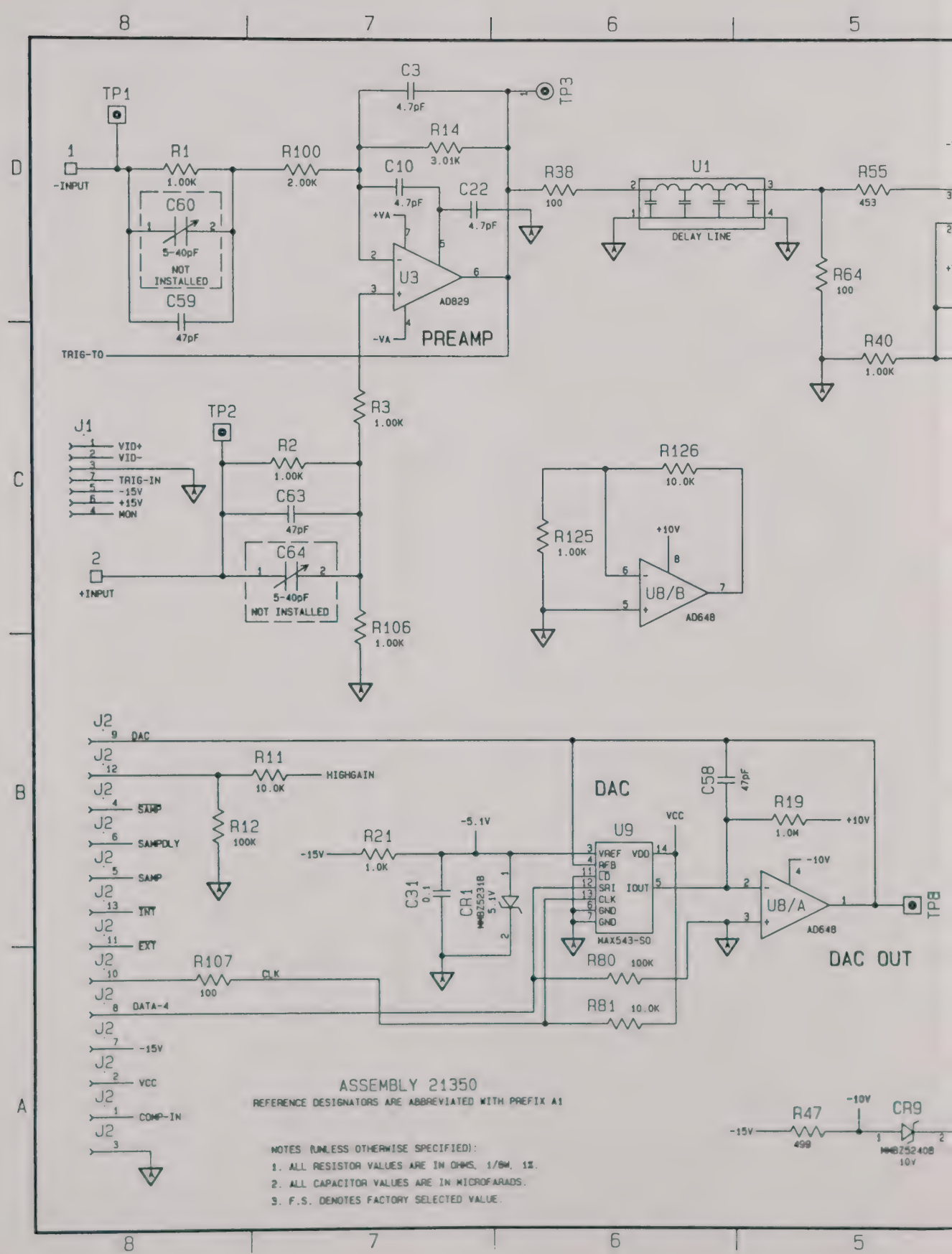
COMPONENT LOCATIO			
CKT REF	GRID LOC	CKT REF	GRID LOC
C1	F3	C51	D2
C2	G2	C52	D3
C3	B1	C53	B2
C5	G2	C54	B3
C6	E3	C58	P3
C7	M2	C59	A2
C8	H2	C60	A1
C9	G2	C63	B3
C10	A2	C64	B3
C11	L3	C66	E2
C12	N1	C67	D2
C13	P1	C68	C2
C14	M2	C70	P2
C15	C3	C71	G3
C16	E3	C72	P3
C21	M2	C73	K2
C22	Q2	C74	G2
C23	C3	C75	M2
C24	D2	C76	L3
C25	N3		
C31	N2		

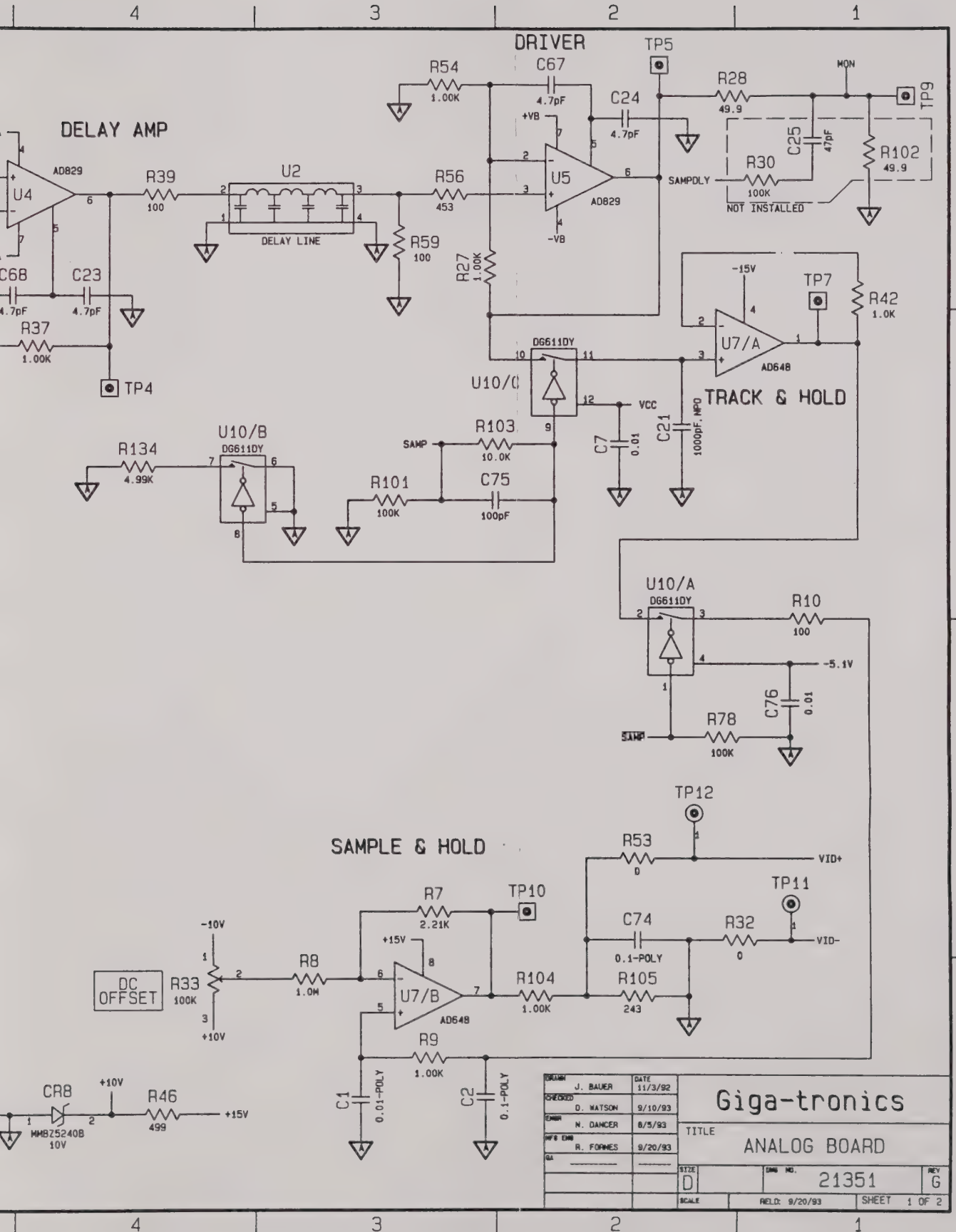


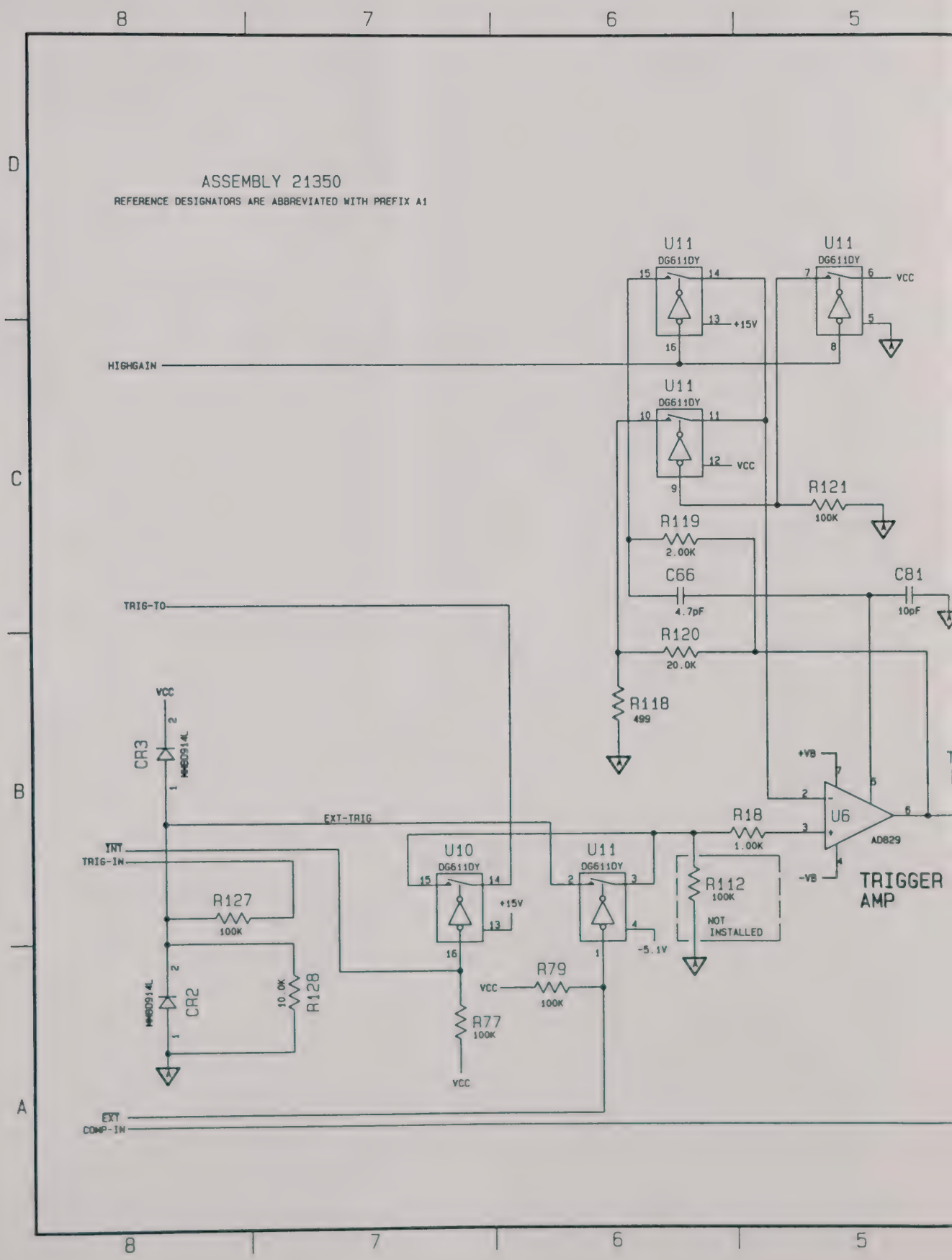
) #21350

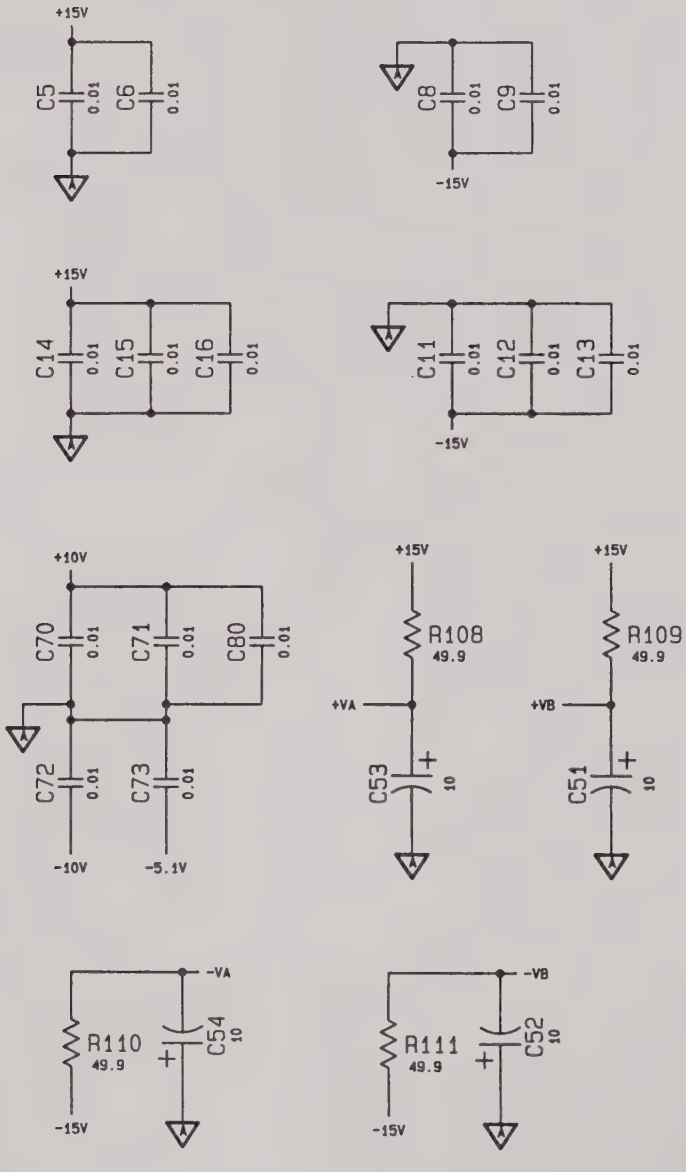
BOTTOM SIDE

TABLE		COMPONENT LOCATION TABLE											
CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
		R1	A2	R37	C1	R77	L2	R118	N3	TP1	A2	U1	B1
C80	P2	R2	B3	R38	B2	R78	L2	R119	L1	TP2	A2	U2	E2
C81	E3	R3	A2	R39	D1	R79	L1	R120	D3	TP3	B1	U3	B2
		R7	G3	R40	C1	R80	D2	R121	K2	TP4	C1	U4	C2
		R8	G3	R42	K3	R81	L2	R125	P3	TP5	D1	U5	D2
		R9	G3	R46	K3			R126	P3	TP6	E1	U6	E2
		R10	L3	R47	K2	R100	A2	R127	K1	TP7	F1	U7	K3
CR1	N2	R14	B2			R101	M2	R128	K2	TP8	C3	U8	P2
CR2	M1					R102	M3	R134	M3	TP9	E3	U9	M2
CR3	L1	R18	M3	R53	H3	R103	M2	R135	C3	TP10	F3	U10	K2
CR8	K3	R19	P2	R54	D1	R104	L2			TP11	H3	U11	K2
CR9	K2	R21	N2	R55	C2	R105	K2			TP12	H3		
				R56	D1	R106	B3						
		R27	D2	R59	N1	R107	D1						
		R28	M3	R64	D1	R108	C3						
		R30	N3			R109	N2						
J1	H3	R32	J3			R110	C3						
J2	L3	R33	G3			R111	C3						
						R112	M3						


TP1
1
-INPUT
R1
1.00K
R100
2.00K
C60
5-40pF
NOT INSTALLED
C59
47pF
C3
4.7pF
TP3
R14
3.01K
C10
4.7pF
C22
4.7pF
+VA
U3
AD829
-VA
PREAMP
TRIG-TO
R38
100
U1
DELAY LINE
R55
453
R64
100
R40
1.00K
J1
VID+
VID-
TRIG-IN
-15V
+15V
MON
TP2
R2
1.00K
C63
47pF
C64
5-40pF
NOT INSTALLED
2
+INPUT
R3
1.00K
R106
1.00K
R126
10.0K
R125
1.00K
+10V
U8/B
AD648
J2
DAC
R11
10.0K
HIGHGAIN
SAMP
R12
100K
SAMPDLY
SAMP
INT
EXT
R107
100
CLK
DATA-4
-15V
VCC
COMP-IN
R21
1.0K
-15V
-5.1V
C31
0.1
CR1
MMBZ5231B
5.1V
U9
VREF
RFB
CS
SRI
CLK
GND
GND
VDD
IOUT
MAX543-SO
VCC
C58
47pF
R19
1.0M
+10V
-10V
U8/A
AD648
TP8
DAC OUT
R80
100K
R81
10.0K
ASSEMBLY 21350
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A1
NOTES (UNLESS OTHERWISE SPECIFIED):
1. ALL RESISTOR VALUES ARE IN OHMS, 1/8W, 1%.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. F.S. DENOTES FACTORY SELECTED VALUE.
R47
499
-15V
-10V
CR9
MMBZ5240B
10V


DRIVER
TP5
R54
1.00K
C67
4.7pF
C24
4.7pF
+VB
R28
49.9
MON
TP9
DELAY AMP
U4
AD829
R39
100
U2
DELAY LINE
R56
453
U5
AD829
-VB
SAMPDLY
R30
100K
NOT INSTALLED
C25
47pF
R102
49.9
C68
4.7pF
C23
4.7pF
R37
1.00K
TP4
R59
100
R27
1.00K
-15V
TP7
R42
1.0K
U7/A
AD648
DG611DY
U10/C
VCC
C7
0.01
C21
1000pF, NPO
TRACK & HOLD
U10/B
DG611DY
R134
4.99K
SAMP
R103
10.0K
R101
100K
C75
100pF
U10/A
DG611DY
R10
100
-5.1V
C76
0.01
R78
100K
SAMP
TP12
R53
0
VID+
TP11
C74
0.1-POLY
R32
0
VID-
SAMPLE & HOLD
R7
2.21K
TP10
-10V
+15V
DC OFFSET
R33
100K
+10V
R8
1.0M
U7/B
AD648
R104
1.00K
R105
243
R9
1.00K
C1
0.01-POLY
C2
0.1-POLY
CR8
MMBZ5240B
10V
+10V
R46
499
+15V
DRAWN J. BAUER 11/3/92
CHECKED D. WATSON 9/10/93
ENGR N. DANCER 8/5/93
MFG ENG R. FORNES 9/20/93
QA
Giga-tronics
TITLE
ANALOG BOARD
SIZE D
DWG NO. 21351
REV G
SCALE
FILE: 9/20/93
SHEET 1 OF 2

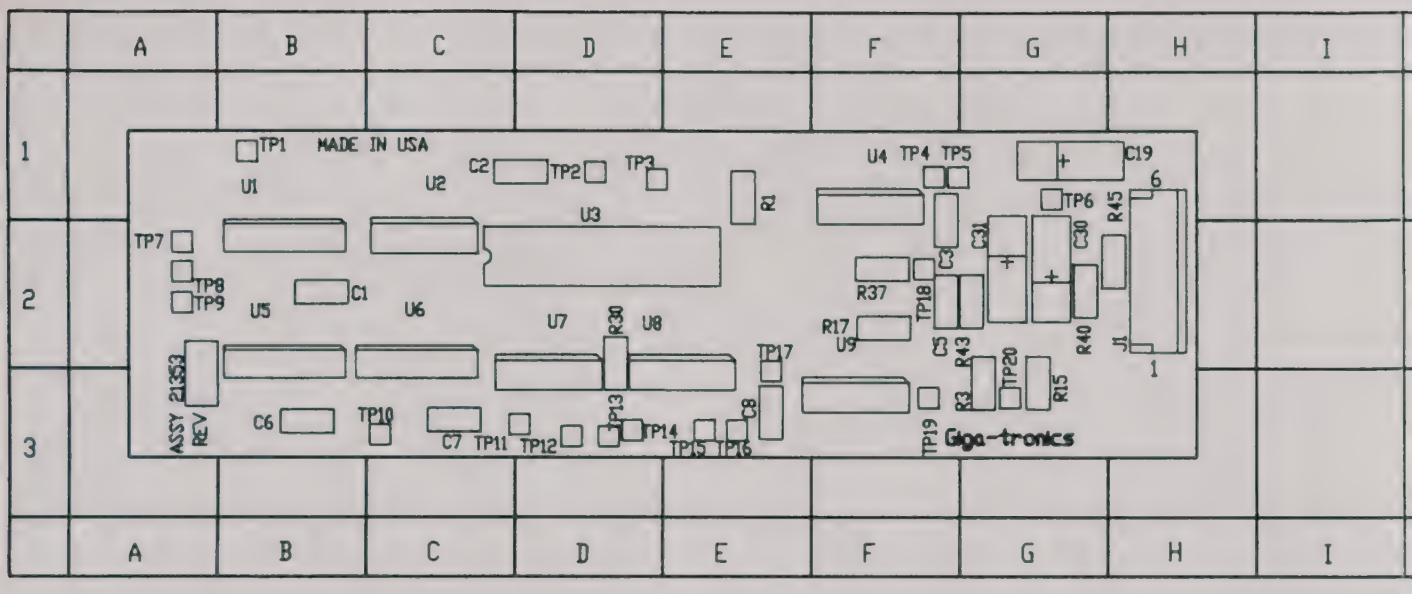

ASSEMBLY 21350
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A1
U11
DG611DY
HIGHGAIN
+15V
VCC
R121
100K
R119
2.00K
C66
4.7pF
C81
10pF
TRIG-TO
R120
20.0K
R118
499
CR3
MMBD914L
EXT-TRIG
INT
TRIG-IN
R127
100K
CR2
10.0K
R128
U10
R79
R77
100K
R18
1.00K
U6
AD829
+VB
-VB
R112
NOT INSTALLED
-5.1V
TRIGGER AMP
EXT
COMP-IN



NOTES (UNLESS OTHERWISE SPECIFIED):

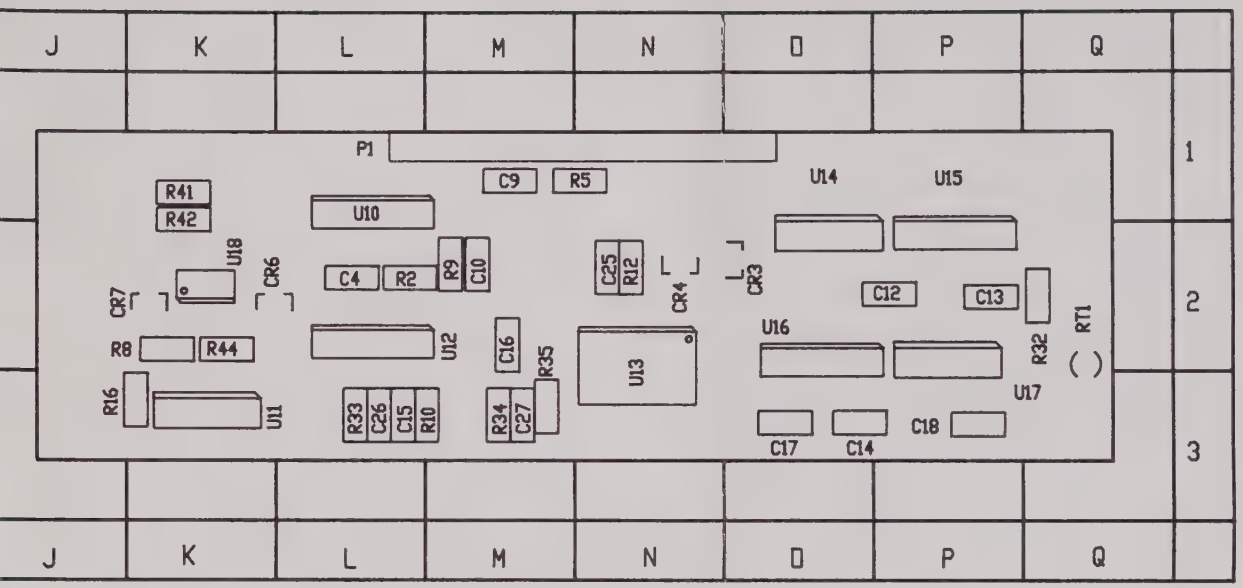
1. ALL RESISTOR VALUES ARE IN OHMS, 1/8W, 1%.
2. ALL CAPACITOR VALUES ARE IN MICROFARADS.
3. F.S. DENOTES FACTORY SELECTED VALUE.

DRAWN J. BAUER	DATE 11/3/92	Giga-tronics
CHECKED D. WATSON	9/10/93	
ENGR N. DANCER	8/5/93	TITLE ANALOG BOARD
MFG ENG R. FORNES	9/20/93	
QA		SIZE D / DWG NO. 21351 / REV G
		SCALE / SHEET 2 OF 2



TOP SIDE

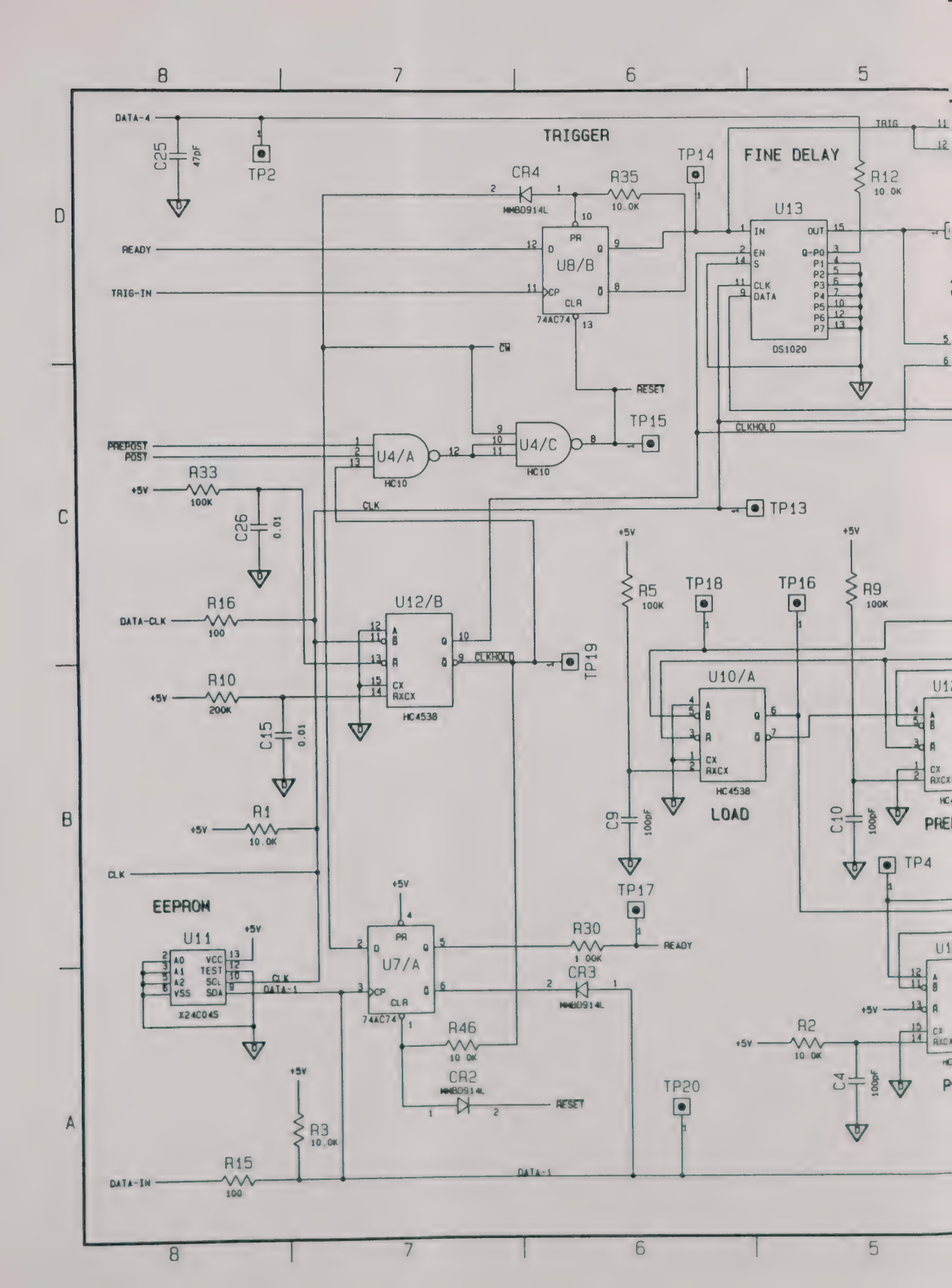
Figure 22. Digital PC Board Ass

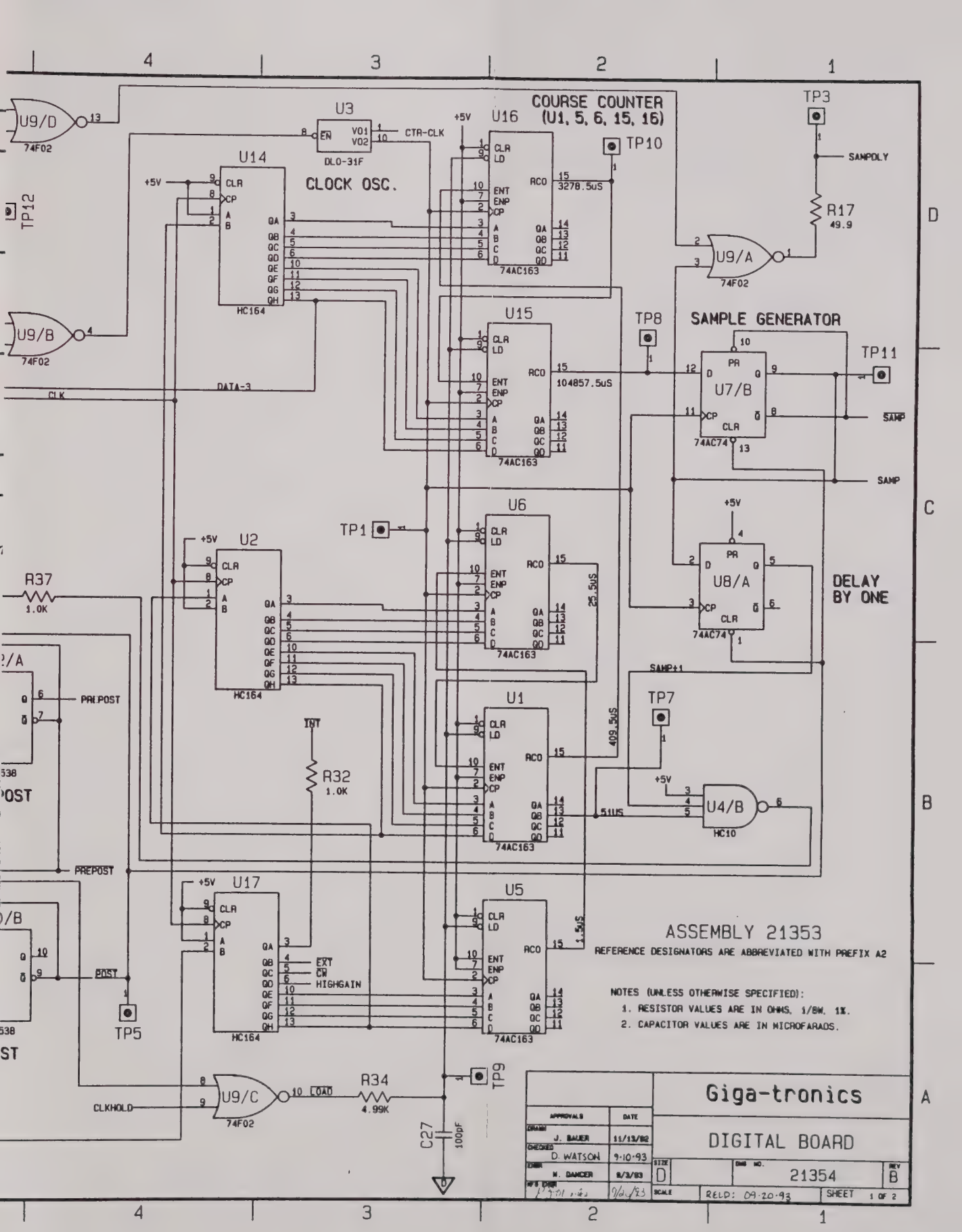


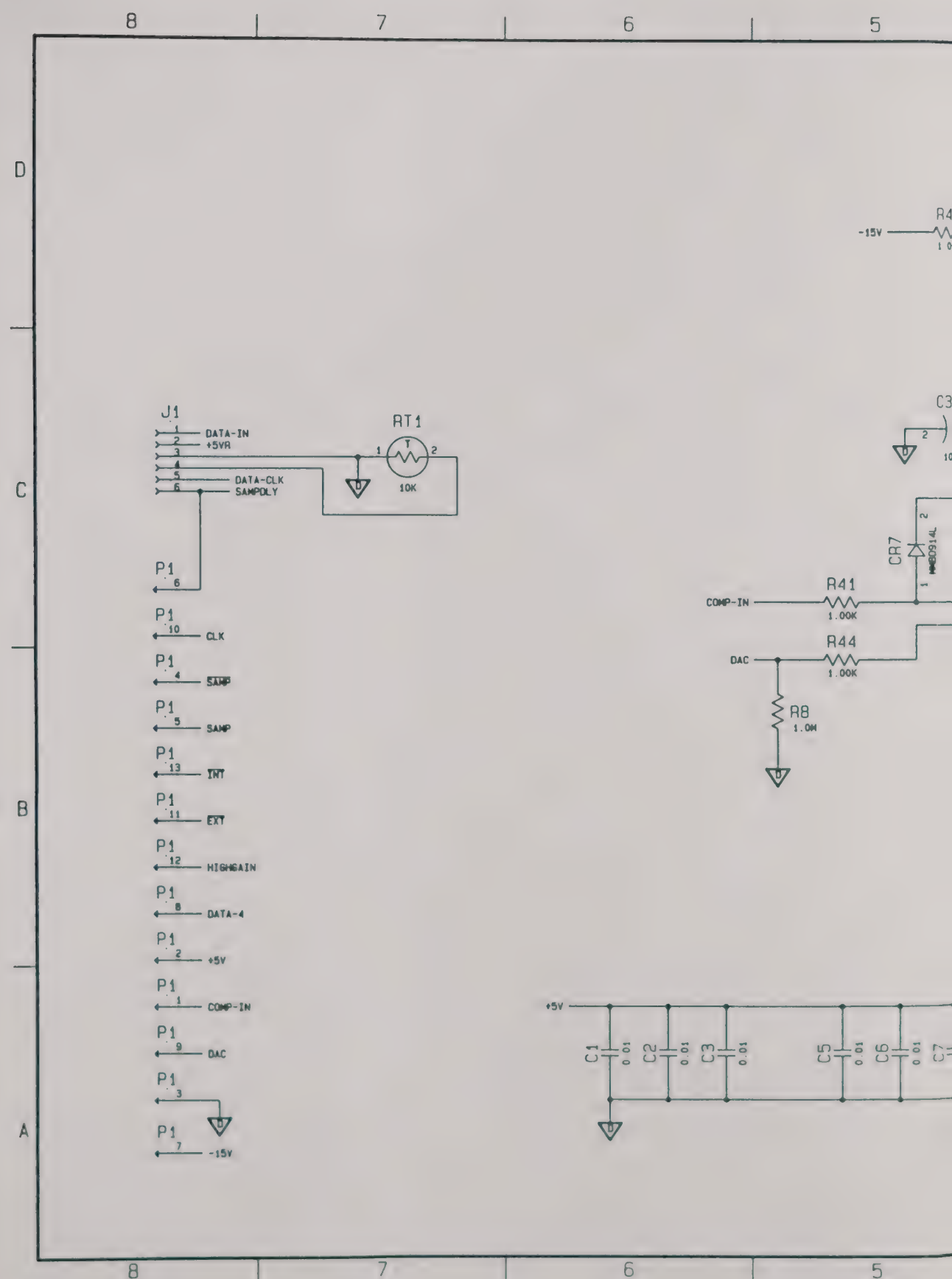
mbly (A2) #21353

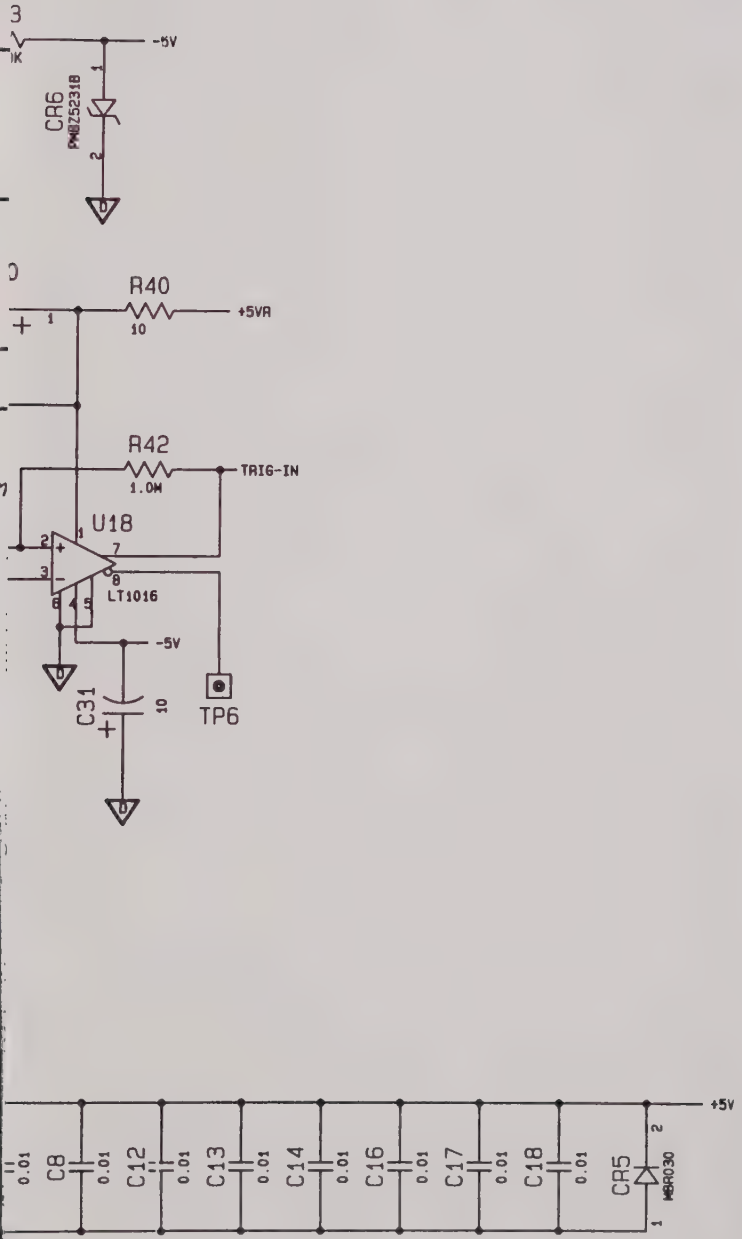
BOTTOM SIDE

COMPONENT LOCATION TABLE						COMPONENT LOCATION TABLE					
CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC	CKT REF	GRID LOC
C1	B2	C25	N2	J1	H2	R30	D2	TP1	B1	U1	B2
C2	C1	C26	L3	P1	L1	R32	Q2	TP2	D1	U2	C2
C3	F1	C27	M3			R33	L3	TP3	D1	U3	D2
C4	L2	C30	G2			R34	M3	TP4	F1	U4	F1
C5	F2	C31	G2	R1	E1	R35	M3	TP5	F1	U5	B2
C6	B3			R2	L2	R37	F2	TP6	G1	U6	C2
C7	C3			R3	G3	R40	G2	TP7	A2	U7	D2
C8	E3			R5	M1	R41	K1	TP8	A2	U8	D2
C9	M1			R8	K2	R42	K1	TP9	A2	U9	F3
C10	M2			R9	M2	R43	G2	TP10	C3	U10	L1
C12	P2			R10	M3	R44	K2	TP11	D3	U11	K3
C13	P2			R12	N2	R45	H2	TP12	D3	U12	L2
C14	O3			R15	G3			TP13	D3	U13	N3
C15	L3	CR3	O2	R16	K3			TP14	D3	U14	O1
C16	M2	CR4	N2	R17	F2			TP15	E3	U15	P1
C17	O3	CR6	K2					TP16	E3	U16	O2
C18	P3	CR7	K2					TP17	E3	U17	P2
C19	G1					RT1	Q2	TP18	F2	U18	K2
								TP19	F3		
								TP20	G3		


TRIGGER
FINE DELAY
DATA-4
C25
47pF
TP2
CR4
MMBD914L
R35
10.0K
TP14
R12
10.0K
U13
IN
OUT
EN
S
CLK
DATA
Q-P0
P1
P2
P3
P4
P5
P6
P7
OS1020
TRIG
READY
TRIG-IN
U8/B
PR
D
Q
CP
CLR
74AC74
CW
RESET
TP15
PREPOST
POST
U4/A
U4/C
HC10
CLKHOLD
R33
+5V
100K
C26
0.01
CLK
TP13
R16
DATA-CLK
100
U12/B
A
B
R
CX
RXCX
HC4538
TP19
R10
200K
C15
0.01
R5
100K
TP18
TP16
R9
100K
U10/A
LOAD
C9
100pF
C10
100pF
TP4
R1
10.0K
TP17
EEPROM
U11
A0
A1
A2
VSS
VCC
TEST
SCL
SDA
X24C04S
U7/A
R30
1.00K
READY
CR3
MMBD914L
R46
10.0K
CR2
MMBD914L
RESET
TP20
R2
10.0K
C4
100pF
R3
10.0K
R15
100
DATA-IN
DATA-1


COURSE COUNTER
(U1, 5, 6, 15, 16)
CLOCK OSC.
SAMPLE GENERATOR
DELAY
BY ONE
U3
DLO-31F
CTR-CLK
U14
HC164
U16
74AC163
3278.5uS
U15
104857.5uS
U6
25.5uS
U1
409.5uS
U5
1.5uS
U2
U17
U7/B
74AC74
U8/A
U4/B
HC10
U9/A
U9/B
U9/C
74F02
TP1
TP3
TP5
TP7
TP8
TP9
TP10
TP11
TP12
SAMPDLY
R17
49.9
R32
1.0K
R34
4.99K
R37
1.0K
C27
100pF
DATA-3
CLK
SAMP
SAMP+1
PRE/POST
POST
INT
EXT
CW
HIGHGAIN
CLKHOLD
LOAD
+5V
ASSEMBLY 21353
REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A2
NOTES (UNLESS OTHERWISE SPECIFIED):
1. RESISTOR VALUES ARE IN OHMS, 1/8W, 1%.
2. CAPACITOR VALUES ARE IN MICROFARADS.
Giga-tronics
DIGITAL BOARD
21354
REV B
SIZE D
SCALE
REL'D: 09-20-93
SHEET 1 OF 2
J. BAUER 11/13/92
D. WATSON 9-10-93
M. DANCER 8/3/93


8
7
6
5
D
C
B
A
J1
1 DATA-IN
2 +5VR
3
4
5 DATA-CLK
6 SAMPDLY
RT1
T
1
2
10K
P1
6
P1
10 CLK
P1
4 SAMP
P1
5 SAMP
P1
13 INT
P1
11 EXT
P1
12 HIGHGAIN
P1
8 DATA-4
P1
2 +5V
P1
1 COMP-IN
P1
9 DAC
P1
3
P1
7 -15V
-15V
R4
1 0
C3
2
10
CR7
2
1
R41
COMP-IN
1.00K
R44
DAC
1.00K
R8
1.0M
+5V
C1
0.01
C2
0.01
C3
0.01
C5
0.01
C6
0.01
C7



ASSEMBLY 21353

REFERENCE DESIGNATORS ARE ABBREVIATED WITH PREFIX A2

NOTES (UNLESS OTHERWISE SPECIFIED):

1. RESISTOR VALUES ARE IN OHMS, 1/8W, 1%.
2. CAPACITOR VALUES ARE IN MICROFARADS.

APPROVALS	DATE
DRAWN J. BAUER	11/13/92
CHECKED D. WATSON	9-10-93
ENGR N. DANCER	9/3/93
MFG ENGR	9/2/93

Giga-tronics

DIGITAL BOARD

SIZE D | DWG NO. 21354 | REV B

SCALE | RELD: 09-20-93 | SHEET 2 OF 2

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80350A PEAK PWR SENSOR HOUSING ASSY #21471

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A4J1	20248	MOD., CONN RCPT AUDIO 14 CONT	GIGA-TRONICS, INC.	WMI 20248
A4J2	21468	CONN,SMB,MALE BHD,JACK	AEP	2019-7511-000
A4J3	21468	CONN,SMB,MALE BHD,JACK	AEP	2019-7511-000
A4J4	21468	CONN,SMB,MALE BHD,JACK	AEP	2019-7511-000
A4P1	21054-002	HOUSING IDC .079 PITCH 7 POS	J.S.T. CORPORATION	07DR-E8M
A4P2	21054-001	HOUSING IDC .079 PITCH 6 POS	J.S.T. CORPORATION	06DR-E8M

80350A PEAK POWER SENSOR ASSY #21472

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1	21350	PCB ASSY,ANALOG	GIGA-TRONICS, INC.	21350
A2	21353	PCB ASSY,DIGITAL	GIGA-TRONICS, INC.	21353
A3	15183	TYPE N 18.5GHZ DET.HSG.ASSY	GIGA-TRONICS, INC.	15183
A4	21471	SENSOR HOUSING ASSY	GIGA-TRONICS, INC.	21471
A5	21563	DET ELEMENT,UNTESTED,80350A	GIGA-TRONICS, INC.	21563
W1	21460-001	CABLE ASSY,BNC-SMB,W,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W2	21460-002	CABLE ASSY,BNC-SMB,R,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W3	21460-003	CABLE ASSY,BNC-SMB,BK,6FT	E.F. JOHNSON CO.CO.	21460-XXX

80350A PEAK POWER SENSOR ASSY #21473

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1	21350	PCB ASSY,ANALOG	GIGA-TRONICS, INC.	21350
A2	21353	PCB ASSY,DIGITAL	GIGA-TRONICS, INC.	21353
A3	15183	TYPE N 18.5GHZ DET.HSG.ASSY	GIGA-TRONICS, INC.	15183
A4	21471	SENSOR HOUSING ASSY	GIGA-TRONICS, INC.	21471
A5	21563	DET ELEMENT,UNTESTED,80350A	GIGA-TRONICS, INC.	21563
W1	21460-001	CABLE ASSY,BNC-SMB,W,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W2	21460-002	CABLE ASSY,BNC-SMB,R,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W3	21460-003	CABLE ASSY,BNC-SMB,BK,6FT	E.F. JOHNSON CO.CO.	21460-XXX

80350A PEAK POWER SENSOR ASSY #21474

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1	21350	PCB ASSY,ANALOG	GIGA-TRONICS, INC.	21350
A2	21353	PCB ASSY,DIGITAL	GIGA-TRONICS, INC.	21353
A3	15183	TYPE N 18.5GHZ DET.HSG.ASSY	GIGA-TRONICS, INC.	15183
A4	21471	SENSOR HOUSING ASSY	GIGA-TRONICS, INC.	21471
A5	21563	DET ELEMENT,UNTESTED,80350A	GIGA-TRONICS, INC.	21563
W1	21460-001	CABLE ASSY,BNC-SMB,W,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W2	21460-002	CABLE ASSY,BNC-SMB,R,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W3	21460-003	CABLE ASSY,BNC-SMB,BK,6FT	E.F. JOHNSON CO.CO.	21460-XXX

80350A PEAK POWER SENSOR ASSY #21475

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1	21350	PCB ASSY,ANALOG	GIGA-TRONICS, INC.	21350
A2	21353	PCB ASSY,DIGITAL	GIGA-TRONICS, INC.	21353
A3	20706-001	8500/SAM DET HSG ASSY,TYPE K	GIGA-TRONICS, INC.	20706-001
A4	21471	SENSOR HOUSING ASSY	GIGA-TRONICS, INC.	21471
A5	21563	DET ELEMENT,UNTESTED,80350A	GIGA-TRONICS, INC.	21563
W1	21460-001	CABLE ASSY,BNC-SMB,W,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W2	21460-002	CABLE ASSY,BNC-SMB,R,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W3	21460-003	CABLE ASSY,BNC-SMB,BK,6FT	E.F. JOHNSON CO.CO.	21460-XXX

80350A PEAK POWER SENSOR ASSY #21476

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1	21350	PCB ASSY,ANALOG	GIGA-TRONICS, INC.	21350
A2	21353	PCB ASSY,DIGITAL	GIGA-TRONICS, INC.	21353
A3	20706-001	8500/SAM DET HSG ASSY,TYPE K	GIGA-TRONICS, INC.	20706-001
A4	21471	SENSOR HOUSING ASSY	GIGA-TRONICS, INC.	21471
A5	21563	DET ELEMENT,UNTESTED,80350A	GIGA-TRONICS, INC.	21563
W1	21460-001	CABLE ASSY,BNC-SMB,W,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W2	21460-002	CABLE ASSY,BNC-SMB,R,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W3	21460-003	CABLE ASSY,BNC-SMB,BK,6FT	E.F. JOHNSON CO.CO.	21460-XXX

80350A PEAK POWER SENSOR ASSY #21477

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1	21350	PCB ASSY,ANALOG	GIGA-TRONICS, INC.	21350
A2	21353	PCB ASSY,DIGITAL	GIGA-TRONICS, INC.	21353
A3	15183	TYPE N 18.5GHZ DET.HSG.ASSY	GIGA-TRONICS, INC.	15183
A4	21471	SENSOR HOUSING ASSY	GIGA-TRONICS, INC.	21471
A5	21563	DET ELEMENT,UNTESTED,80350A	GIGA-TRONICS, INC.	21563
W1	21460-001	CABLE ASSY,BNC-SMB,W,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W2	21460-002	CABLE ASSY,BNC-SMB,R,6FT	E.F. JOHNSON CO.CO.	21460-XXX
W3	21460-003	CABLE ASSY,BNC-SMB,BK,6FT	E.F. JOHNSON CO.CO.	21460-XXX

ANALOG PC BOARD ASSEMBLY #21350

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1C1	16258-007	CAP,METAL POLY,0.01UF	WIMA	MKS2/0.01UF/10%/63
A1C2	16258-006	CAP METAL POLY 0.1uF 10% 63V	WIMA	MKS2/0.1uF/10%/63
A1C3	20961-014	CAP,CER,X7R,4.7PF (SM0805)	KCK AMERICA	CE4R7D2NO-T2
A1C5	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C6	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C7	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C8	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C9	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1C10	20961-014	CAP,CER,X7R,4.7PF (SM0805)	KCK AMERICA	CE4R7D2N0-T2
A1C11	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C12	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C13	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C14	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C15	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C16	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C21	20962-011	CAP,CER CHIP,NPO,1000PF,50V	KCK AMERICA	CE102J2N0-T2
A1C22	20961-014	CAP,CER,X7R,4.7PF (SM0805)	KCK AMERICA	CE4R7D2N0-T2
A1C23	20961-014	CAP,CER,X7R,4.7PF (SM0805)	KCK AMERICA	CE4R7D2N0-T2
A1C24	20961-014	CAP,CER,X7R,4.7PF (SM0805)	KCK AMERICA	CE4R7D2N0-T2
A1C31	20961-007	CAP CER CHIP X7R 0.1UF 10% 50V	ARCO	MC1210X104KS500/TR
A1C51	21627-001	CAP,TANT,10UF,25V,CWR11,(SM)	KEMET	T492D106M025MS
A1C52	21627-001	CAP,TANT,10UF,25V,CWR11,(SM)	KEMET	T492D106M025MS
A1C53	21627-001	CAP,TANT,10UF,25V,CWR11,(SM)	KEMET	T492D106M025MS
A1C54	21627-001	CAP,TANT,10UF,25V,CWR11,(SM)	KEMET	T492D106M025MS
A1C58	20962-003	CAP CER CHIP NPO 47pF 10% 50V	ARCO	MC0805N470KS500/TR
A1C59	20962-003	CAP CER CHIP NPO 47pF 10% 50V	ARCO	MC0805N470KS500/TR
A1C60	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1C63	20962-003	CAP CER CHIP NPO 47pF 10% 50V	ARCO	MC0805N470KS500/TR
A1C64	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1C66	20961-014	CAP,CER,X7R,4.7PF (SM0805)	KCK AMERICA	CE4R7D2N0-T2
A1C67	20961-014	CAP,CER,X7R,4.7PF (SM0805)	KCK AMERICA	CE4R7D2N0-T2
A1C68	20961-014	CAP,CER,X7R,4.7PF (SM0805)	KCK AMERICA	CE4R7D2N0-T2
A1C70	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C71	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C72	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C73	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C74	16258-006	CAP METAL POLY 0.1uF 10% 63V	WIMA	MKS2/0.1uF/10%/63
A1C75	20961-012	CAP CER CHIP X7R 100PF 10% 50V	ARCO	MC0805X101KS500/TR
A1C76	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C80	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A1C81	20962-007	CAP CER CHIP NPO 10PF 50V	JOHANSON DIELECTRICS, INC	500R15N100DW2-T
A1CR1	21443	DIODE,5.1V (SM)	PHILIPS DISCRETE SEMI BUS	PMBZ5231B
A1CR2	20968	DIODE, SIGNAL 914 (SOT-23)	MOTOROLA (SPD)	MMBD914L
A1CR3	20968	DIODE, SIGNAL 914 (SOT-23)	MOTOROLA (SPD)	MMBD914L
A1CR8	21444	DIODE,10V (SM)	MOTOROLA (SPD)	MMBZ5240B
A1CR9	21444	DIODE,10V (SM)	MOTOROLA (SPD)	MMBZ5240B
A1J1	21055-002	HEADER STR .079 PITCH 7 POS	J.S.T. CORPORATION	B07-DR
A1J2	21458-001	CONN,PIN,13 POS	SAMTEC	BBL-113-T-E
A1R1	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R2	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R3	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R7	21445-006	RES,MF,2.21K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT2211F
A1R8	21445-012	RES,MF,1.00M,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1004F
A1R9	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R10	21445-003	RES,MF,100,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1000F
A1R11	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A1R12	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A1R14	21445-004	RES,MF,3.01K,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT3011F
A1R18	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R19	21445-012	RES,MF,1.00M,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1004F
A1R21	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R27	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R28	21445-014	RES,MF,49.9,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT49R9F
A1R32	21445-018	RES,MF,0 OHM JUMPER (SM0805)	KOA SPEER ELECTRONICS, IN	RM73Z2AT
A1R33	21024-001	RES VAR SMT 16T 100K OHM 20%	BOURNS, INC.	3269P-1-104
A1R37	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A1R38	21445-003	RES,MF,100,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1000F
A1R39	21445-003	RES,MF,100,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1000F
A1R40	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R42	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R46	21445-009	RES,MF,499,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT4990F
A1R47	21445-009	RES,MF,499,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT4990F
A1R53	21445-018	RES,MF,0 OHM JUMPER (SM0805)	KOA SPEER ELECTRONICS, IN	RM73Z2AT
A1R54	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R55	21445-007	RES,MF,453,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT4530F
A1R56	21445-007	RES,MF,453,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT4530F
A1R59	21445-003	RES,MF,100,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1000F
A1R64	21445-003	RES,MF,100,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1000F
A1R77	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A1R78	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A1R79	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A1R80	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A1R81	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A1R100	21445-013	RES,MF,2.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT2001F
A1R101	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A1R103	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A1R104	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R105	21445-015	RES,MF,243,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT2430F
A1R106	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R107	21445-003	RES,MF,100,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1000F
A1R108	21445-014	RES,MF,49.9,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT49R9F
A1R109	21445-014	RES,MF,49.9,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT49R9F
A1R110	21445-014	RES,MF,49.9,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT49R9F
A1R111	21445-014	RES,MF,49.9,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT49R9F
A1R112	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1R118	21445-009	RES,MF,499,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT4990F
A1R119	21445-013	RES,MF,2.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT2001F
A1R120	21445-017	RES,MF,20.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT2002F
A1R121	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A1R125	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A1R126	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A1R127	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A1R128	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A1R134	21445-016	RES,MF,4.99K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT4991F
A1TP1	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1TP2	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1TP3	21456-001	TEST POINT,BLK	COMPONENTS CORPORATION	TP-105-01-00
A1TP4	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1TP5	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1TP6	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1TP7	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1TP8	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1TP9	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1TP10	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A1TP11	21456-001	TEST POINT,BLK	COMPONENTS CORPORATION	TP-105-01-00
A1TP12	21456-001	TEST POINT,BLK	COMPONENTS CORPORATION	TP-105-01-00
A1U1	21455	IC,DELAY LINE,1513-50B	DATA DELAY DEVICES, INC.	1513-50B
A1U2	21455	IC,DELAY LINE,1513-50B	DATA DELAY DEVICES, INC.	1513-50B
A1U3	21447	IC,AD829 (SM)	ANALOG DEVICES	AD829JR
A1U4	21447	IC,AD829 (SM)	ANALOG DEVICES	AD829JR
A1U10	21448	IC,DG611 (SM)	SILICONIX INCORPORATED	DG611DY
A1U11	21448	IC,DG611 (SM)	SILICONIX INCORPORATED	DG611DY

DIGITAL PC BOARD ASSEMBLY #21353

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A2C1	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C2	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C3	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C4	20961-012	CAP CER CHIP X7R 100PF 10% 50V	ARCO	MC0805X101KS500/TR
A2C5	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C6	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C7	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C8	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C9	20961-012	CAP CER CHIP X7R 100PF 10% 50V	ARCO	MC0805X101KS500/TR
A2C10	20961-012	CAP CER CHIP X7R 100PF 10% 50V	ARCO	MC0805X101KS500/TR
A2C12	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C13	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C14	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C15	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C16	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C17	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C18	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C19	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2C25	20962-003	CAP CER CHIP NPO 47pF 10% 50V	ARCO	MC0805N470KS500/TR
A2C26	20961-005	CAP CER CHIP X7R .01UF 10% 50V	ARCO	MC0805X103KS500/TR
A2C27	20961-012	CAP CER CHIP X7R 100PF 10% 50V	ARCO	MC0805X101KS500/TR
A2C30	21628-001	CAP,TANT,10UF,15V,CWR11,(SM)	KEMET	T492C106M015MS
A2C31	21628-001	CAP,TANT,10UF,15V,CWR11,(SM)	KEMET	T492C106M015MS
A2CR2	20968	DIODE, SIGNAL 914 (SOT-23)	MOTOROLA (SPD)	MMBD914L
A2CR3	20968	DIODE, SIGNAL 914 (SOT-23)	MOTOROLA (SPD)	MMBD914L
A2CR4	20968	DIODE, SIGNAL 914 (SOT-23)	MOTOROLA (SPD)	MMBD914L
A2CR5	20517	RECTIFIER, SCHOTTKY POWER	DIODES, INC.	SD103A
A2CR6	21443	DIODE,5.1V (SM)	PHILIPS DISCRETE SEMI BUS	PMBZ5231B
A2CR7	20968	DIODE, SIGNAL 914 (SOT-23)	MOTOROLA (SPD)	MMBD914L
A2J1	21056-001	HEADER RT ANG .079 PITCH 6 POS	J.S.T. CORPORATION	S06B-DR
A2J2	21457-001	CONN,SKT,13 POS	SAMTEC	SS-113-T-2
A2R1	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A2R2	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A2R3	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A2R5	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A2R8	21445-012	RES,MF,1.00M,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1004F
A2R9	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A2R10	21445-005	RES,MF,200K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT2003F
A2R12	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F
A2R15	21445-003	RES,MF,100,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1000F
A2R16	21445-003	RES,MF,100,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1000F
A2R17	21445-014	RES,MF,49.9,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT49R9F
A2R30	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A2R32	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A2R33	21445-002	RES,MF,100K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1003F
A2R34	21445-016	RES,MF,4.99K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT4991F
A2R35	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A2R37	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A2R40	21445-010	RES,MF,10.0,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT10R0F
A2R41	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A2R42	21445-012	RES,MF,1.00M,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1004F
A2R43	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A2R44	21445-001	RES,MF,1.00K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1001F
A2R45	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2R46	21445-011	RES,MF,10.0K,1%,1/8W (SM0805)	KOA SPEER ELECTRONICS, IN	RK73H2AT1002F

Reference Designator	Part Number	Description	Manufacturer	Manuf. Part Number
A2RT1	15208-001	THERMISTOR, PARALLEL 10K OHM	QUALITY THERMISTOR, INC.	PER WMI PRINT
A2TP1	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP2	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP3	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP4	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP5	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP6	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP7	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP8	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP9	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP10	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP11	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP12	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP13	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP14	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP15	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP16	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP17	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP18	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP19	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2TP20	XXXXX-XXA	PART NOT INSTALLED	GIGA-TRONICS, INC.	0
A2U1	21551-001	IC,74ACT163 (SM-SOIC16)	MOTOROLA (SPD)	MC74ACT163D
A2U2	20859-004	IC 8-BIT SER-IN/PAR-OUT SR	MOTOROLA (SPD)	MC74HC164D
A2U3	21526	DELAY LINE ASSY	GIGA-TRONICS, INC.	21526
A2U4	20859-008	IC,74HC10 (SM)	HARRIS CORP	CD74HC10M
A2U5	21551-001	IC,74ACT163 (SM-SOIC16)	MOTOROLA (SPD)	MC74ACT163D
A2U6	21551-001	IC,74ACT163 (SM-SOIC16)	MOTOROLA (SPD)	MC74ACT163D
A2U7	21478-001	IC,74AC74 (SM-SOIC14)	HARRIS CORP	CD74AC74M
A2U8	21478-001	IC,74AC74 (SM-SOIC14)	HARRIS CORP	CD74AC74M
A2U9	21452-001	IC,74F02 (SM)	NATIONAL SEMICONDUCTOR	74F02SC
A2U10	20859-005	IC DUAL PRCN MNSTBMV W/RESET	SGS	M74HC4538M1
A2U11	20983	IC 512 X 8-BIT CMOS EEPROM	XICOR	X24C04S
A2U12	20859-005	IC DUAL PRCN MNSTBMV W/RESET	SGS	M74HC4538M1
A2U13	21453	IC,DS1020 (SM)	DALLAS SC	DS1020S-50
A2U14	20859-004	IC 8-BIT SER-IN/PAR-OUT SR	MOTOROLA (SPD)	MC74HC164D
A2U15	21551-001	IC,74ACT163 (SM-SOIC16)	MOTOROLA (SPD)	MC74ACT163D
A2U16	21551-001	IC,74ACT163 (SM-SOIC16)	MOTOROLA (SPD)	MC74ACT163D
A2U17	20859-004	IC 8-BIT SER-IN/PAR-OUT SR	MOTOROLA (SPD)	MC74HC164D
A2U18	17415	IC,UFAST PRECISION COMPARATOR	LINEAR TECHNOLOGY	LT1016CS8

GIGA-TRONICS WORLD WIDE SALES & SERVICE

Domestic Representatives (listed alphabetically by rep name)

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Columbia, MD.
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Phone: (214) 661-0300
Fax: (214) 490-0836

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Phone: (713) 579-2995
Fax: (713) 579-2998

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Phone: (512) 338-4701
Fax: (512) 338-0873

San Antonio, TX.
Phone: (210) 342-3031
Fax: (210) 525-8680

Metairie, LA.
Phone: (504) 833-3655
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Fax: (316) 263-3189

Eastern Instrument. of PA
Southampton, PA.
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Fax: (215) 355-3469

Jack Howard Associates
San Antonio, TX.
Phone: (210) 828-5741
Fax: (210) 828-3207

Micro Concepts
Mclean, VA.
Phone: (703) 893-8108
Fax: (703) 893-7267

EM Technical Associates
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Phone: (315) 437-6410
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Fax: (206) 867-0742

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Fax: (503) 645-5186
(also Alaska & Hawaii)

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Fax: (201) 440-4474

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Fax: (407) 682-7443

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Fax: (407) 777-6705

Huntsville, AL.
Phone: (205) 534-6020
Fax: (205) 534-6059

Alpharetta, GA.
Phone: (404) 664-9797
Fax: (404) 664-9795

Greensboro, NC.
Phone: (919) 632-9370
Fax: (919) 632-7372

Test-Rep Associates, Inc.
Littleton, MA.
Phone: (617) 937-6713
Fax: (508) 534-0486

Torkelson Associates
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Phone: (612) 835-2414
Fax: (612) 835-5470

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Fax: (708) 670-0828

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Fax: (414) 784-7969

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Fax: (619) 292-8364

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Fax: (513) 434-6590

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Fax: (216) 524-0276

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Fax: (313) 588-9332

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Fax: 61-8-281-4194
(Maroubra, N.S.W.)
Phone: 61-2-344-5200
Fax: 61-2-349-2602

Belgium
Air Parts Electronics
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Fax: 32-2-241-8130

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Fax: (613) 820-3213
(Toronto)
Phone: (416) 674-8970
Fax: (416) 674-8986
(Vancouver)
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Fax: (604) 582-2161

Chile
Avantec Technologia de Avanzada Ltd
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Fax: 56-2-632-5444

China
Corad Technology Ltd.
(Beijing)
Phone: 861-832-5904
Fax: 861-832-5903
(Hong Kong)
Phone: 852-793-0330
Fax: 852-793-0606
(Shanghai)
Phone: 862-1-433-0001
Fax: 862-1-431-9532

Denmark
Crimp A/S
Phone: 45-4810-0500
Fax: 45-4810-0555

England
Sematron (UK) Ltd.
Phone: 44-734-819970
Fax: 44-734-819786

France
Elexience
Phone: 33-1-60-119471
Fax: 33-1-60-119809

Finland
Profelec OY
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Fax: 3580-566-2998

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PC Electronic GMBH
Phone: 49-6047-6949
Fax: 49-6047-6408

Greece
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Phone: 301-524-0620
Fax: 301-524-9995

Holland
Air Parts Int'l B.V.
Phone: 31-1720-43221
Fax: 31-1720-20651

Hong Kong
Schmidt Scientific
Phone: 852-507-0222
Fax: 852-827-5656

India
Technical Trade Links
(Bombay)
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Fax: 91-22-837-6719
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Phone: 91-11-573-6074
Fax: 91-11-575-5812
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Phone: 91-33-753-877
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Dan-El Technologies Ltd.
Phone: 972-3-544-1466
Fax: 972-3-544-1468

Italy
L. P. Instruments
(Milan)
Phone: 39-2-4840-1713
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Sematron Europe S.R.L.
(Rome)
Phone: 011-39-6-8689-5015
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Japan
Midoriya Electric Co. Ltd.
(Tokyo)
Phone: 81-3-3-561-5763
Fax: 81-3-3-561-5794
(Osaka)
Phone: 81-6-262-0934
Fax: 81-6-261-5909

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Unitek
Phone: 822-2712761
Fax: 822-5398629

Lebanon
Mabek
Phone: 961-1-864479
Fax: None

New Zealand
Racal New Zealand Ltd.
Phone: 64-4-473-0313
Fax: 64-4-499-1540

Norway
Morgenstierne AS
Phone: 47-22-289490
Fax: 47-22-289-494

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BMP Ingenieros S.A.
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Fax: 46 -8-580-17990

Switzerland
Isatel Electronics AG
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Schmidt Scientific
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Elektro
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Equilab C.A.
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Equilab - Maracaibo
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